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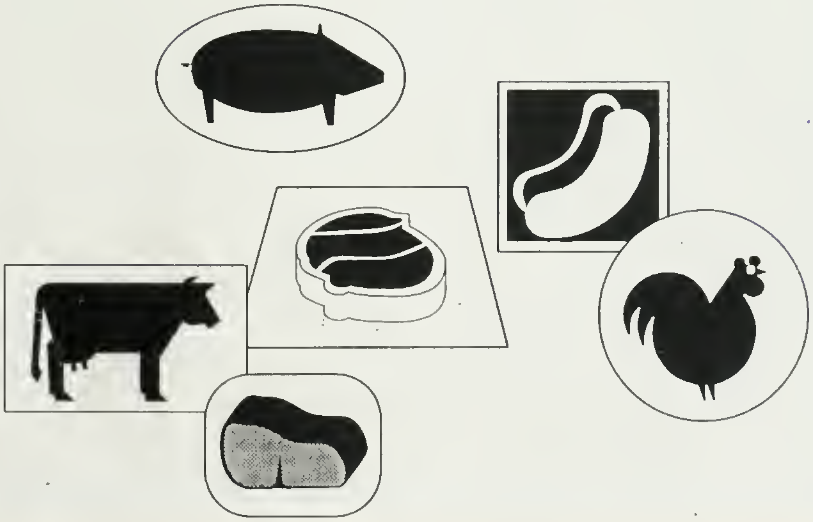
RESOURCE CONSERVATION

# GUIDE TO Resource Conservation and Cost Savings Opportunities in the ➲ Meat and Poultry Sector



Ministry of the Environment

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# Guide to
# Resource Conservation
# and
# Cost Savings Opportunities
# in the
# ➲ Meat and Poultry Sector

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Wardrop Engineering Inc.

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## SUMMARY

The key objective of this study was to prepare generic check lists of opportunities in the meat and poultry sector for energy and water use reduction and pollution prevention.

The following generic check lists were prepared for the study:

- ▸ Process flow diagrams highlighting energy, water and environmental effects for four major types of processes: beef, hogs, poultry and rendering.
- ▸ Check lists of improvement opportunities, including low cost/no cost activities and key efficiency opportunities for each type of process, as well as for associated utilities and services.
- ▸ Check list of new technologies that are either currently being researched and developed, or are being utilized elsewhere, but are not yet fully accepted by Ontario based industries.

These check lists are designed to be a starting point for plant specific assessments, undertaken either by industry personnel or by outside consultants.

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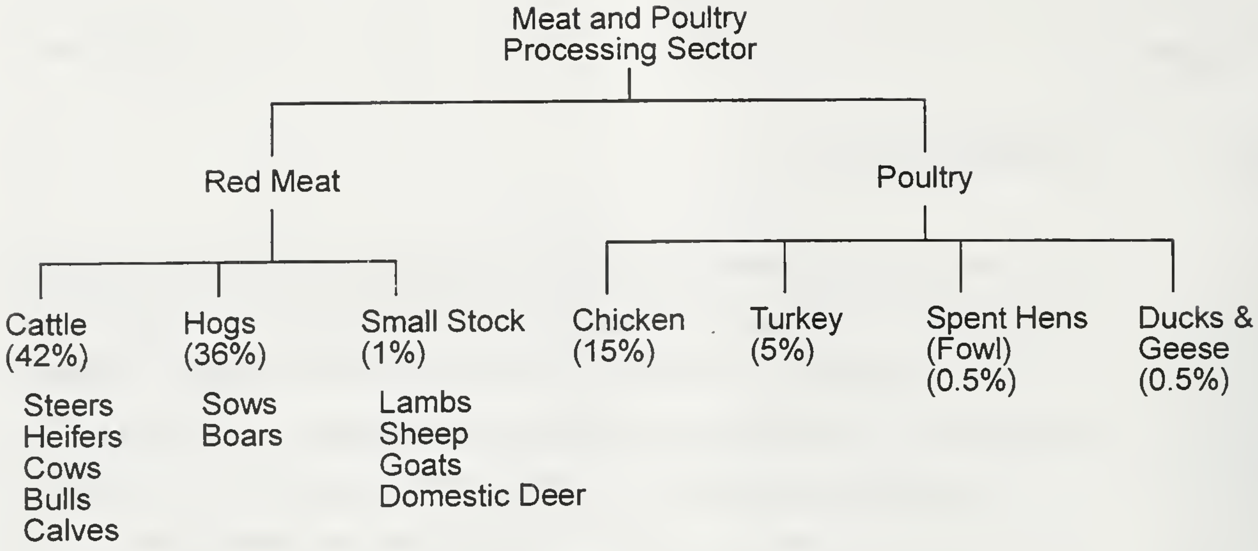
# 1.0 INTRODUCTION

Meat and poultry processing involves the slaughtering of food animals and the preparation of various types of fresh, frozen and further-process meat products for human consumption. This industry was selected by the Industry Programs Branch of the Ontario Ministry of Environment and Energy for a sector-specific study to highlight opportunities for energy and water conservation, and reduction of environmental releases at source. The choice was supported by the Ontario Ministry of Agriculture and Food (OMAF), and was based on the fact that this sub-sector:

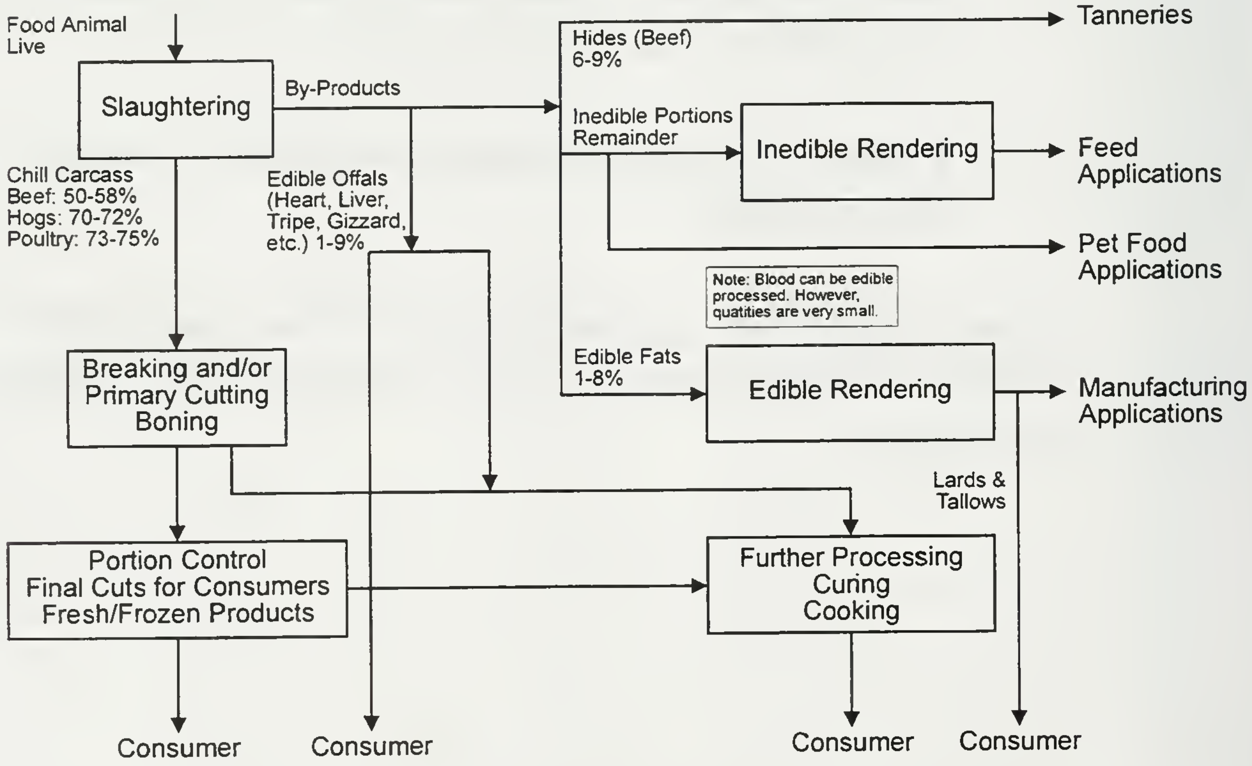
- Is highly significant to the economy of Ontario;
- Shows good promise of energy/water efficiency improvement and environmental release reduction at source; and
- Is amenable to improvements through the use of existing, and up-and-coming technologies.

Wardrop Engineering Inc. was engaged to conduct the study, with the Terms of Reference presented in Appendix A. The study methodology is briefly presented in Appendix B.



Note: Proportion of value represented by species based on total approximate Farm Gate Returns in Ontario for 1993 as a common basis. Refer to Appendix B for details.

Figure 1: Sector Categorization



Note: Blood can be edible processed. However, quatities are very small.

Figure 2: Generic Overview Process Flow for Meat and Poultry Processing

## 2.0 SECTOR PROFILE

Establishments involved in meat and poultry processing are typically categorized by the type of animal species involved. A breakdown of the sector by major categories of food animals is provided in Figure 1, along with the approximate proportion of value represented by each species.

Meat and poultry processing also involves a variety of sequential and interrelated activities, progressing from initial slaughter through to finished consumer products, and various byproducts. A generic overview of the major activities and the flow of materials is provided in Figure 2, along with relevant yield ranges. Processing activities are in some cases highly integrated within single plants, while in other cases, different processing activities are conducted at different sites.

More detail on the current profile of the meat and poultry processing industry in Ontario is provided in Appendix C. This includes its current economic status, energy, water and resource use, costs of energy and water per unit of production, infrastructure needs and usages, environmental pressure points, and anticipated trends.

For the purpose of this report, four major processes have been considered:

- Beef, including calves and small stock:
- Hogs;

- Poultry; and

- Rendering, edible and inedible.

## Energy and Environmental Effects

The energy and environmental effects of meat and poultry processing tend to be more acute toward the initial slaughtering and primary processing operations. This is where the bulk of opportunities exist for energy and water use reduction, and environmental improvement.

The scale of operations is also important with regard to energy and environmental effects. There is a relatively small number of large plants, which account for the majority of overall numbers in the processing of beef, hogs, chicken and turkeys. There are approximately 12 to 15 large plants in Ontario, defined somewhat arbitrarily as processing more than approximately 500 cattle per day, 2,500 hogs per day, 50,000 chickens per day or 6,000 turkeys per day. These operations, by virtue of being larger in size, consuming correspondingly greater amounts of water and energy, and generating greater potential environmental loads, are specifically emphasized in the identification of improvement opportunities.

There is also a large number of small processing plants. There are approximately 220 to 230 small plants in Ontario with meat or poultry processing as a primary activity, although the number at any time may vary, depending on the level of activity and business turnovers.

These small plants, in general, mirror the activities undertaken at the major process operations, the difference being the smaller numbers of animals processed at each plant. However, in certain niche markets such as lambs and calves the small plants as an aggregate handle the majority of livestock.

Small plants have somewhat differing concerns. While energy use, water use, and effluent generation are all proportionately smaller, the handling of animal byproducts and blood is a much more important issue. Large plants typically either incorporate integrated on-site rendering and blood processing facilities, or generate sufficient material to be attractive for off-site renderers. The small plants are too small to economically allow for on-site rendering using conventional technology, have difficulty accessing a renderer, and typically must pay to have materials removed.

### Regulations

Meat and poultry processing are highly regulated industries, primarily to ensure the maintenance of product quality and food safety required for human consumption. Relevant statutes for meat and poultry facilities include those listed in Appendix D. The interpretation of regulations is an important consideration in the implementation of improvement opportunities, especially with regard to appropriate water reuse. For example, regulations dictate specific temperatures that must be maintained in specific process areas, and also indicate specific requirements with regard to water use and reuse.

## TABLE 1

## ENERGY CONSUMPTION RANGE IN VARIOUS MEAT PROCESSING OPERATIONS

| SPECIES TYPE | ELECTRICITY | THERMAL ENERGY |
|---|---|---|
| Beef (Calves and Small Stock) | .07 to .25 kWh/kg DW | 200 to 500 kJ/kg DW |
| Hogs | .07 to .30 kWh/kg HDW | 500 to 900 kJ/kg HDW |
| Poultry | .13 to .25 kWh/bird | 1,200 to 2,000 kJ/bird |
| Rendering | 0.05 to 0.15 kWh/kg input | 1,800 to 7,000 kJ/kg input (for average raw material with 58% moisture) |

## TABLE 2

## WATER CONSUMPTION IN VARIOUS MEAT PROCESSING OPERATIONS

| SPECIES TYPE | WATER CONSUMPTION |
|---|---|
| Beef (Calves and Small Stock) | 800 to 1,700 L per Carcass |
| Hogs | 180 to 450 L per Hog Range<br>Reasonable target is<br>180 to 230 L per Hog |
| Poultry | 12 to 55 L per Bird for Chicken<br>Desired Target is<br>12 to 18 L per Bird Range<br>90 to 118 L per Bird for Turkey |
| Rendering | 5 to 20 L/kg Input throughput<br>(condenser and washup)<br>Recycle of water employed<br>Net water producer (condensate from product) |

## Energy and Water Use

Energy and water consumption ranges for meat and poultry plants, categorized according to the four major processes, are summarized in Table 1 and Table 2 respectively. The range of data presented is drawn from various sources, including literature and direct contacts. Actual consumption can vary substantially from plant to plant, being dependent on capacity, product mix, and other site specific factors.

Rendering is clearly the most energy intensive process, based on total energy use per kilogram input material. In general, beef processing is the least energy intensive process, with hogs and poultry processing intermediate in nature. Energy consumption also tends to be better documented by individual processing plants than water consumption.

Poultry processing tends to be the most water intensive process, based on water use per kilogram of input or final product. Beef and hog processing have lower water use requirements. Water consumption in rendering is fairly significant, primarily for condenser cooling, however, water recycling is frequently undertaken, substantially reducing fresh water requirements.

Unfortunately, the collection and compilation of accurate water use data historically has not been a priority for industries in general. This trend is reflected in the meat and poultry processing sector.

The lack of accurate data is due in part to the typical low cost associated with this resource in the past, and its frequent treatment as more of a fixed or overhead cost, rather than a variable manufacturing cost. Because of the presence of inherently inadequate or inaccurate data, caution should be exercised if extrapolating any water data presented in this report to individual plants.

Extrapolations of energy and water use for the entire meat and poultry processing sector are provided in Appendix C. Additional data on energy use compiled under the Industrial Energy Services Program is summarized in Appendix E.

### Trends

Different sectors of meat and poultry processing in Ontario have experienced differing trends, in terms of throughput and production, as follows:

- Cattle processing has declined steadily.
- Hog processing has remained constant.
- Poultry processing has increased steadily.

It is likely that these trends will continue into the near future. In addition, the number of large operating plants for all types of processes has declined as a result of business restructuring and rationalization. At the same time, the number and throughput of smaller plants have increased, and are likely to continue to increase into the near future.

## 3.0 PROCESSES AND UTILITIES

Four generic process descriptions were developed for meat and poultry processing, and associated activities:

- Beef (including Calves and Small Stock): Figure 3.
- Hogs: Figure 4.
- Poultry: Figure 5.
- Rendering (edible and inedible): Figure 6.

These generic process descriptions include all the relevant steps from initial slaughtering through to final products, as well as byproduct rendering.

On each diagram, the basic process flow is presented sequentially. On the left side of each diagram, high energy and water uses are highlighted at each relevant step, while major environmental effects are highlighted on the right.

The typical utility and service demands for meat and poultry processing are summarized in Table 3. The importance of the different utilities can vary significantly between processes, and to some extent from plant to plant. For example, rendering is a steam intensive process, while a steam boiler may not actually be required in beef, poultry or hog processing unless cooking or smoking processes are undertaken.

Refrigeration is important in beef, poultry and hog processing, with temperatures specified by regulations. Vapour compression refrigeration systems, based on freons, such as R11 and R502, are typically used by the industry. Ammonia is used to some extent, but is not common. CFC replacement is thus, an important issue for most meat and poultry plants.

Smaller stand-alone refrigeration systems are typically used for each major individual location in the plant, rather than a single centralized refrigeration system. The load is thus segregated into three typical levels using smaller systems:

- Low temperature for "sharp" and holding freezers.
- Medium temperature for chill coolers, holding coolers, and immersion chillers.
- High temperature for cutting, deboning and process rooms.

Important indicators of environmental concerns at meat and poultry plants include the following:

- Handling of by-products. It is desirable to maximize the collection and rendering of all by-products, and to reduce material that must be treated or disposed.

- Handling of blood. Blood has a very high BOD, and can be particularly problematic in effluent. It is desirable to ensure that the maximum amount of blood is segregated and dealt with appropriately to minimize the fugitive quantities that end up in the effluent.

- Presence of wastewater treatment. While pollution prevention measures are preferred to end-of-pipe treatment, it is important to ensure that effluent discharge limits are not exceeded. The most common treatment method presently used is dissolved air flotation (DAF). While this technology can effectively reduce the effluent load of fat, suspended solids and BOD, alternate opportunities are available to achieve the same objective, and at the same time save the costs associated with flocculating chemicals and land-disposal of resulting wet sludge. These are discussed in the section on improvement opportunities.

## TABLE 3

## TYPICAL UTILITY AND SERVICE REQUIREMENTS FOR MEAT AND POULTRY PROCESSING

| UTILITY | DEMAND REQUIREMENTS | APPLICABLE PROCESS |
|---|---|---|
| Cold Water: | | |
| 10°C City | Rinsing, Washing, Cooling | Beef, Poultry, Hogs |
| 1-2°C Chilled | Immersion Chilling | Poultry |
| Hot Water: | | |
| 82°C (2.6.3)* | Sterilization (Sanitizers) | Beef, Poultry, Hogs |
| 50-60°C | Scald, Dehair, Defeather | Hogs, Poultry |
| 37-43°C | Washup | Beef, Poultry, Hogs |
| Steam:<br>Approx 790 kPa abs<br>Lower 790 kPa abs | Cooking and Drying<br>Cooking, Water Heating | Rendering (high demand) Beef, Poultry, Hogs |
| Natural Gas: | | |
| Open Burners | Singeing | Hogs |
| Furnace | Space Heating | All |
| Boiler | Hot Water/Space Heating | All |
| Refrigeration: | | |
| -25°C (2.8.7)* | Sharp Freezers | Beef, Poultry, Hogs |
| -18°C (2.8.7)* | Holding Freezer | Beef, Poultry, Hogs |
| 2°C (2.8.5)* | Chill Coolers | Beef, Poultry, Hogs |
| 4°C (2.8.5)* | Holding Coolers | Beef, Poultry, Hogs |
| 10°C (2.8.8)* | Cutting and Deboning | Beef, Poultry, Hogs |
| Compressed Air | Drive pistons, Stunners, Lifting and Lowering Devices | Beef, Poultry, Hogs |
| Electrical (Direct Uses) | Stunners<br>Chain Conveyor Motors, Small Tools, and Misc Drives | Poultry, Hogs<br>Beef, Poultry, Hogs and Rendering |

*Note: Temperatures required under Federal Meat Inspection Regulations.

FIGURE 3: GENERIC BEEF PROCESS (INCLUDING SMALL STOCK)

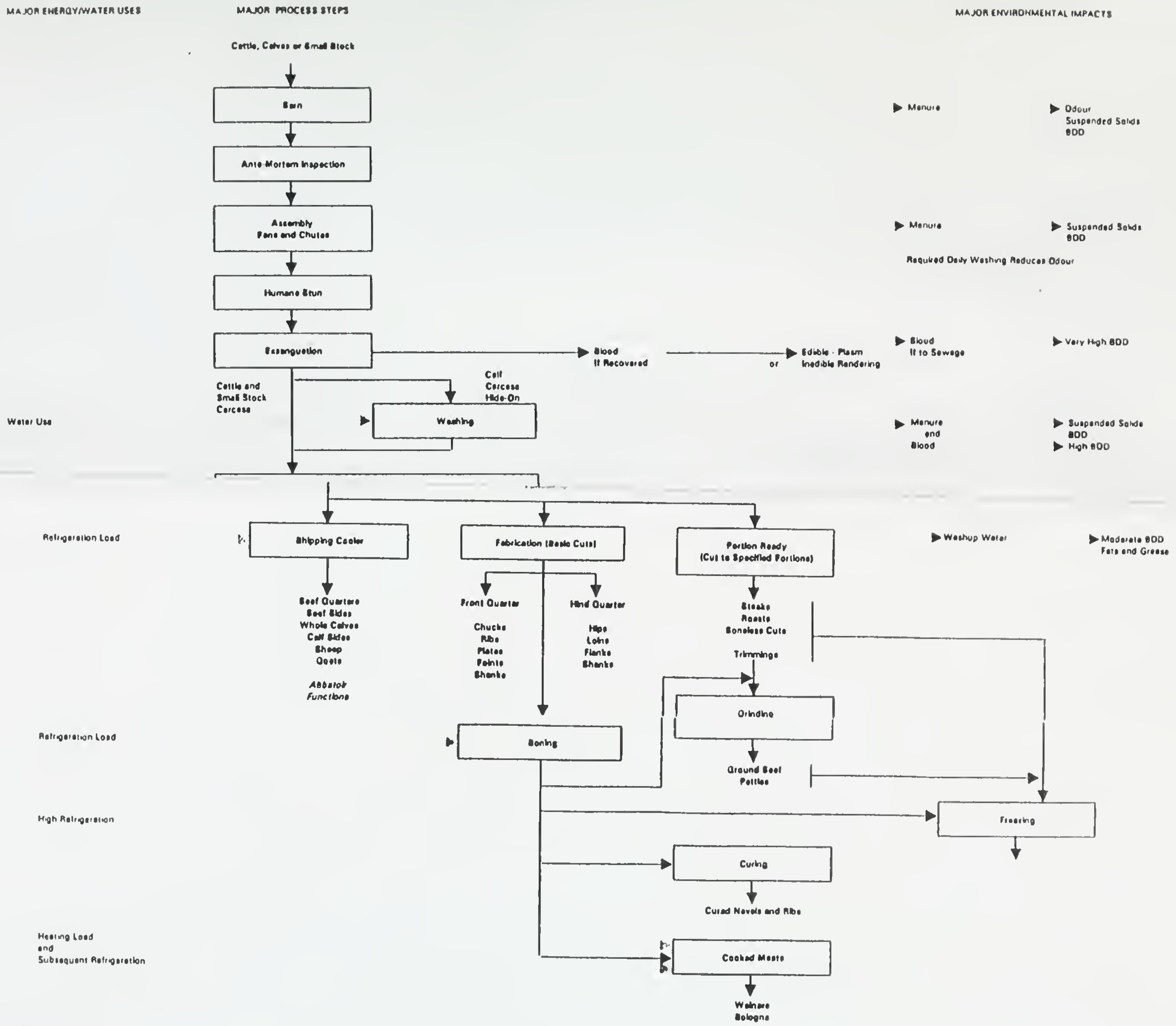
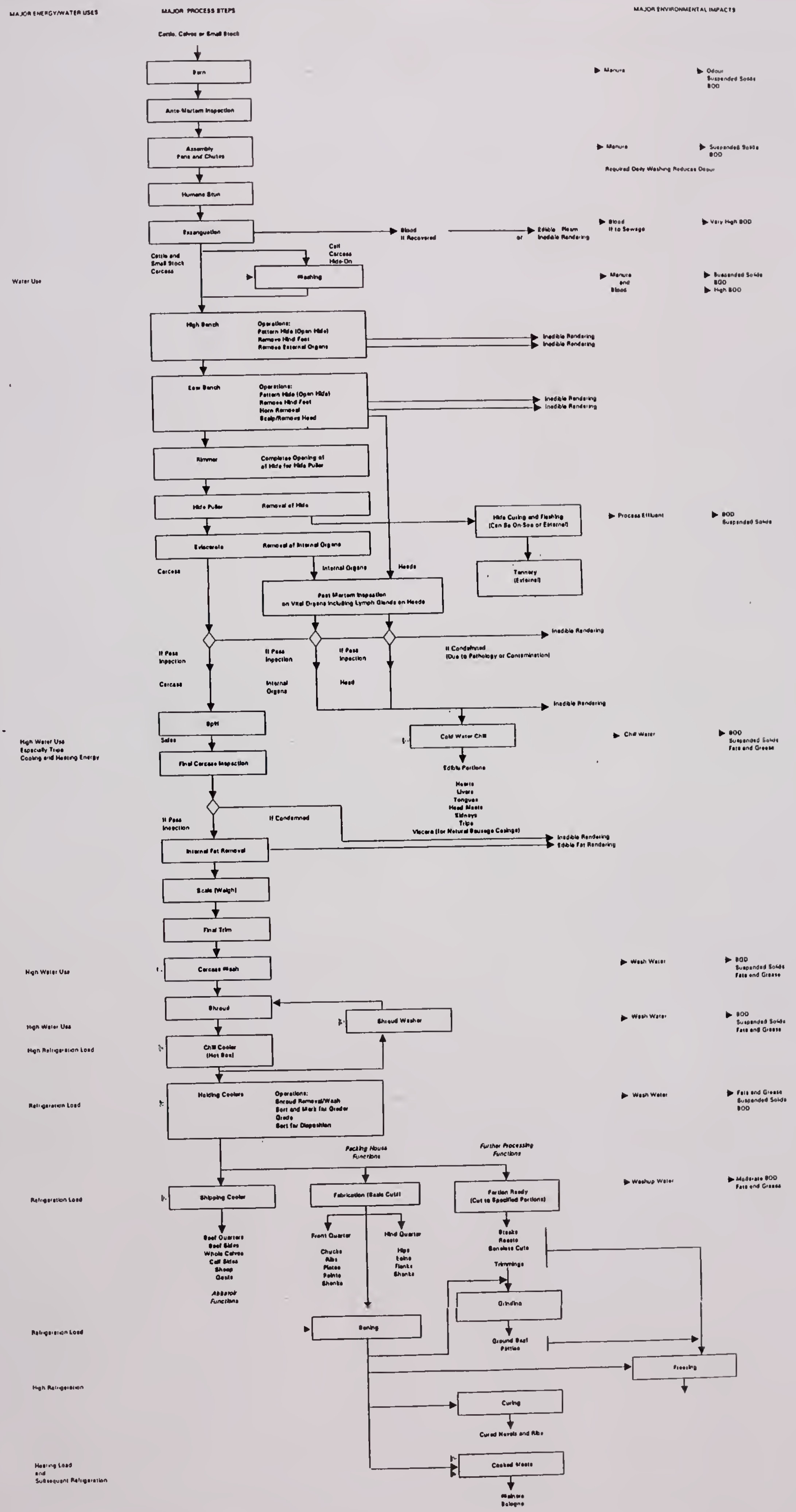


FIGURE 3: GENERIC BEEF PROCESS (INCLUDING SMALL STOCK)



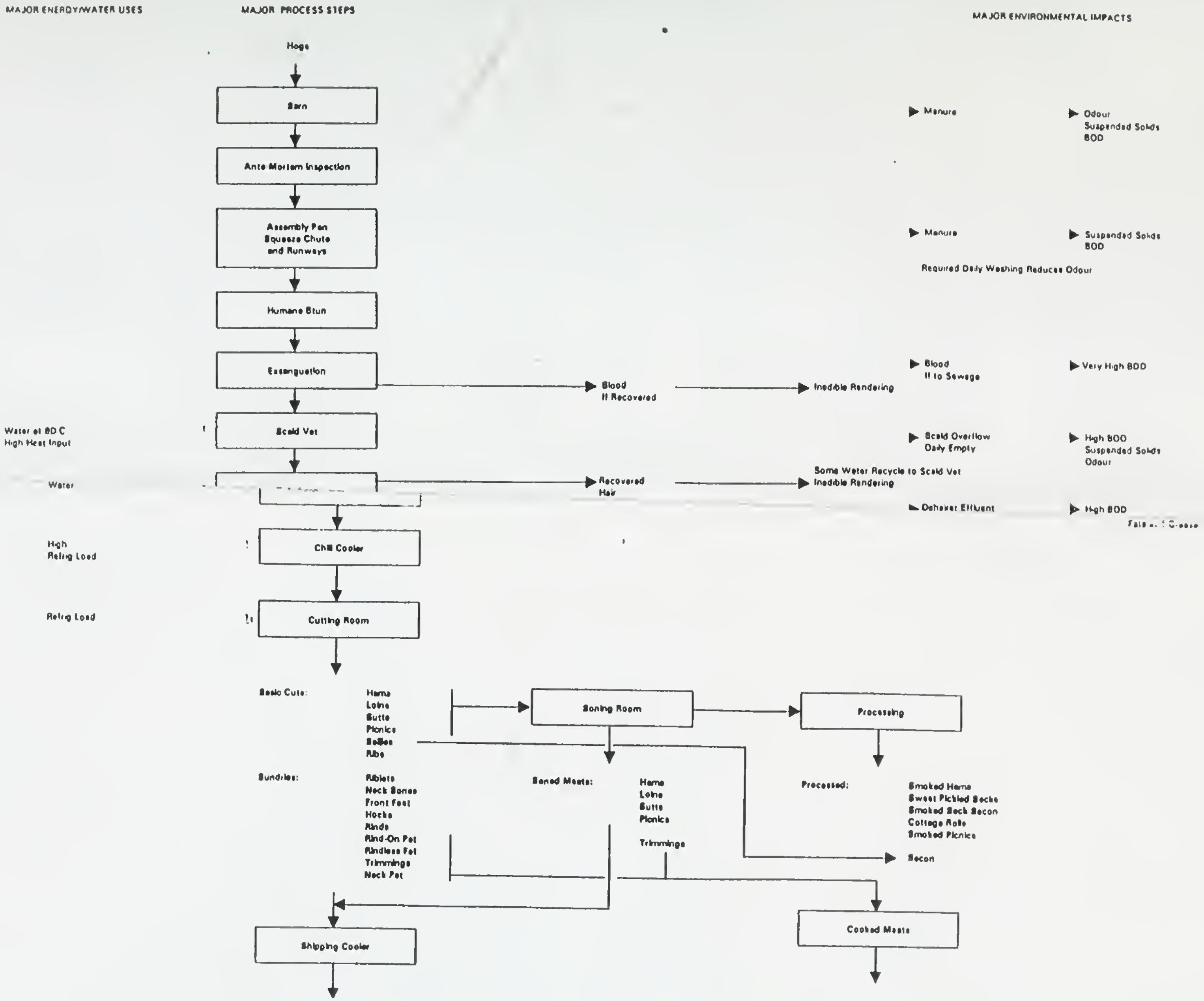

MAJOR ENERGY/WATER USES
MAJOR PROCESS STEPS
MAJOR ENVIRONMENTAL IMPACTS
Hogs
Barn
Ante Mortem Inspection
Assembly Pen
Squeeze Chute
and Runways
Humane Stun
Exsanguation
Scald Vat
Chill Cooler
Cutting Room
Water at 80 C
High Heat Input
Water
High
Refrig Load
Refrig Load
Manure
Odour
Suspended Solids
BOD
Manure
Suspended Solids
BOD
Required Daily Washing Reduces Odour
Blood
If Recovered
Inedible Rendering
Blood
If to Sewage
Very High BOD
Scald Overflow
Daily Empty
High BOD
Suspended Solids
Odour
Recovered
Hair
Some Water Recycle to Scald Vat
Inedible Rendering
Dehairer Effluent
High BOD
Fats and Grease
Basic Cuts:
Hams
Loins
Butts
Picnics
Bellies
Ribs
Sundries:
Riblets
Neck Bones
Front Feet
Hocks
Rinds
Rind-On Fat
Rindless Fat
Trimmings
Neck Fat
Boning Room
Processing
Boned Meats:
Hams
Loins
Butts
Picnics
Trimmings
Processed:
Smoked Hams
Sweet Pickled Backs
Smoked Back Bacon
Cottage Rolls
Smoked Picnics
Bacon
Cooked Meats
Shipping Cooler

FIGURE 4: GENERIC HOG PROCESS

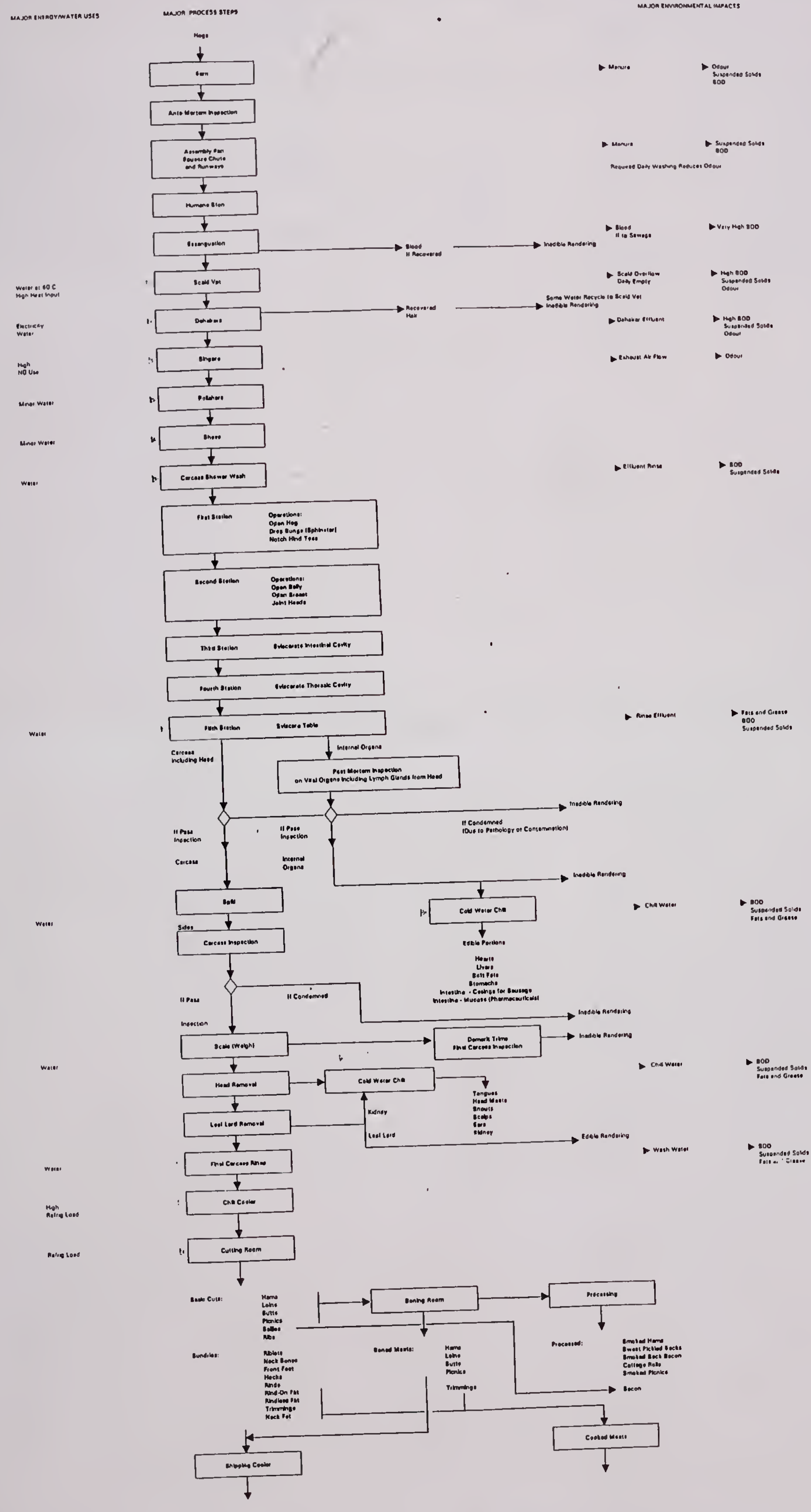


FIGURE 5: GENERIC POULTRY PROCESS

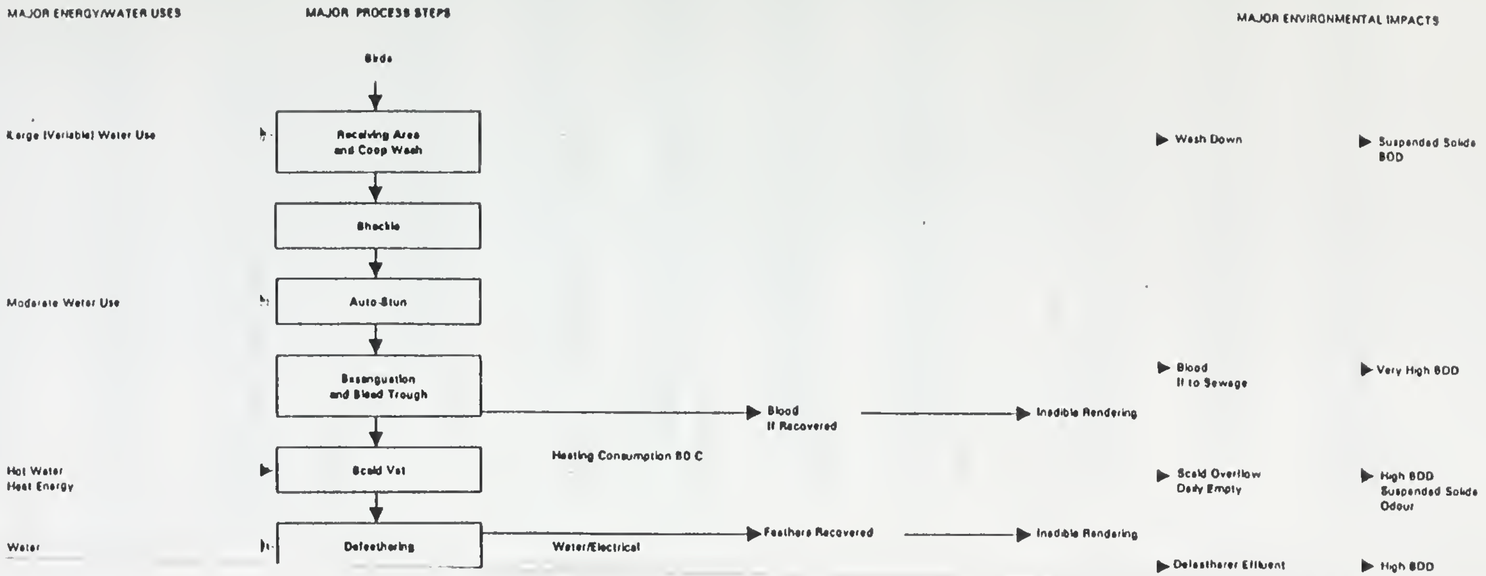
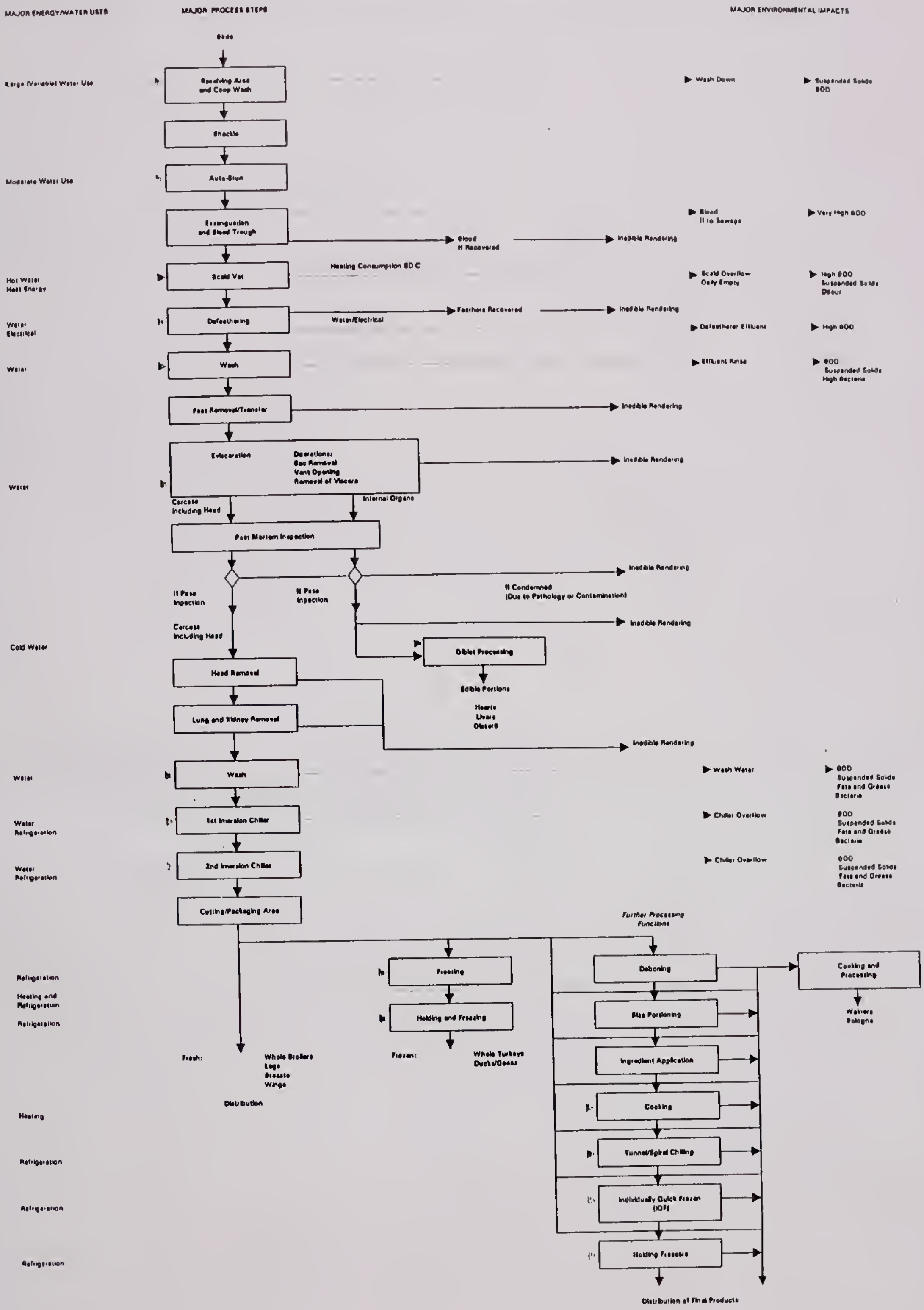


FIGURE 5: GENERIC POULTRY PROCESS



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| Company | Site activities | ETSU ref no |
|---|---|---|
| Gulf Oil Refining Ltd | Oil refinery | RD/7/21 |
| Shell UK Ltd | Oil refinery | RD/19/26 |
| Tioxide Plc | Titanium dioxide manufacturer | RD/6/13 |
| Proctor and Gamble Ltd | Soap and detergent manufacturer | RD/8/19 |
| Staveley Chemicals | Production of organic chemicals | RD/30/31 |
| William Blythe Ltd | Production of inorganic chemicals | RD/5/20 |
| Cray Valley Products Ltd | Production of synthetic resins | RD/13/15 |
| Beecham Pharmaceuticals | Solvent recovery unit | RD/16/17 |
| Long John International | Grain whisky distillery | RD/4/9 |
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| Cadbury Typhoo Ltd | Milk and beverage powder manufacturers | RD/12/23 |
| Express Foods | Creamery | RD/22/29 |
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| J Lyons & Co Ltd | Food processors | RD/20/27 |
| East Lancashire Paper Mill | Paper manufacturer | RD/15/18 |
| St Regis International | Paper manufacturer | RD/17/16 |
| Sheerness Steel | Steel Works | RD/18/25 |
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| May & Baker Ltd. | Speciality Chemicals Plant Process Integration Study - A Summary | RD/051 |
| May & Baker Ltd. | Cost Reduction on Speciality Chemicals | RD/059 |
| Batchelors Foods Ltd. | Cost Reductions on Processed Food Plant | RD/061 |

Copies of the above reports may be obtained from the Ontario Ministry of Energy by writing to :
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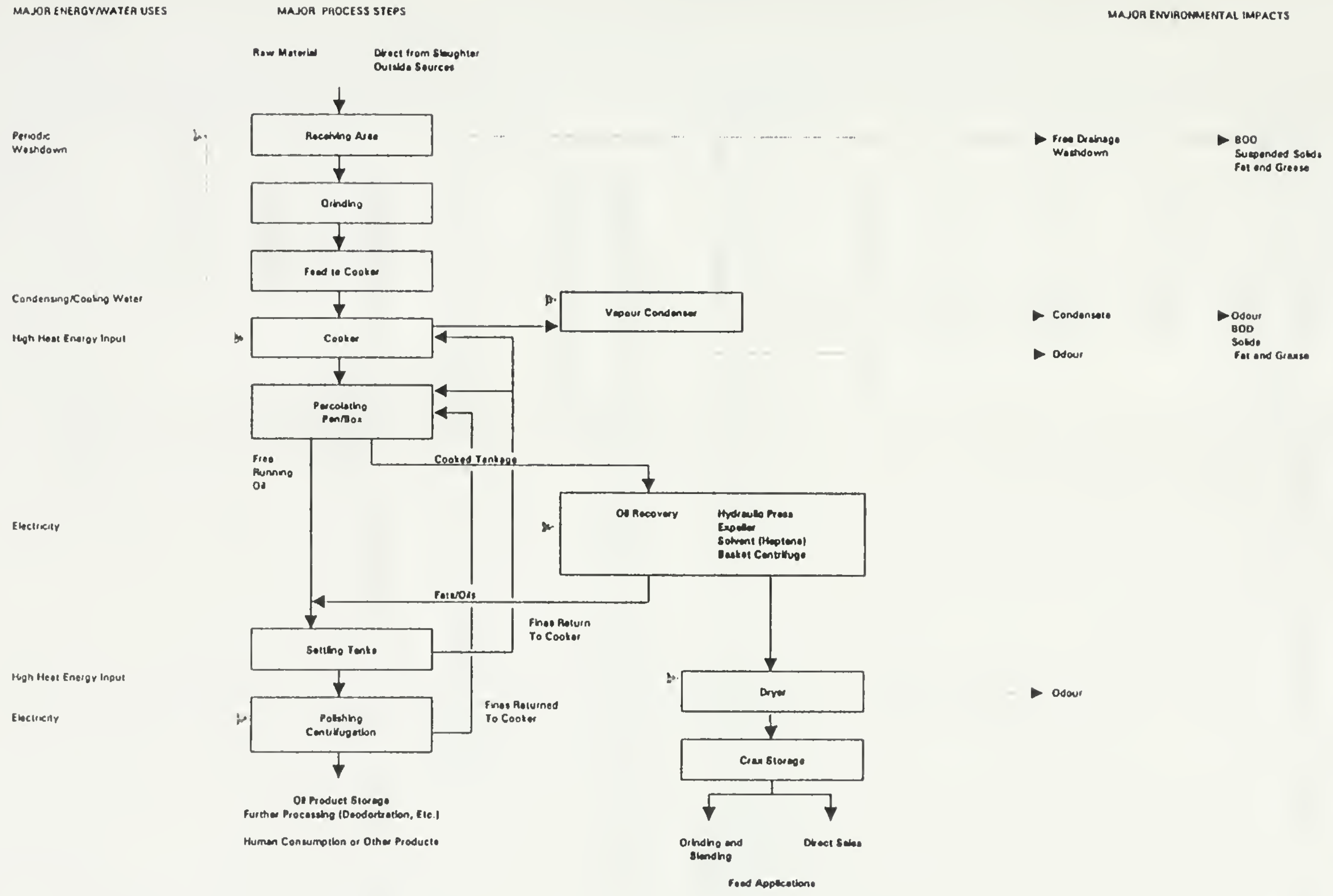
## FIGURE 6: GENERIC BYPRODUCT RENDERING PROCESS (EDIBLE OR INEDIBLE)



## 4.0 IMPROVEMENT OPPORTUNITIES

For each of the four basic processes described earlier a generic checklist was prepared. These checklists will assist in the identification of process related improvement opportunities incorporating energy/water efficiency and pollution prevention. These checklists are as follows:

- Beef: Table 4.
- Hogs: Table 5.
- Poultry: Table 6.
- Rendering: Table 7.

Each of the tables is organized in the same sequence as the generic process diagrams presented in the last section. For each step the table provides:

- Identification of relevant concerns, relating to thermal energy, power, electricity and water use.
- Low cost/no cost measures that can be implemented.
- Applicable retrofit technology options, cross-referenced to Table 8.
- Comments.

In Table 8, the retrofit options applicable to direct process improvements have been categorized into twelve technology groups. For each, a range of probable capital costs, probable savings and resulting paybacks are presented. Each of these technology groups is generic, and should be used as a guide only when assessing applicability and viability at specific plants. Minor capital equipment items, such as nozzles and hose valves, are identified as such in Tables 5 through 8, and are not presented in any further detail.

A checklist of generic utility improvement opportunities is presented in Table 9, with the corresponding retrofit options presented in Table 10. These tables are provided in the same format as the process technology tables.

# TABLE 4: CHECK LIST OF IMPROVEMENT OPPORTUNITIES IN BEEF PROCESSING PLANT

| PROCESS AREA | CONCERNS | | | | OPERATING, LOW COST/NO COST | RETROFIT | TECH REF. | COMMENTS |
|---|---|---|---|---|---|---|---|---|
| | Thermal | Power | Environment | Water | | | | |
| Barns, Assembly Pens and Chutes | Heating to above freezing | Ventilation | Odour, solids, BOD | Variable, mostly for washup. | Screening to separate solids in effluent | Air scrubber, absorption beds for odour control | 8.1 | Proper slopes for troughs and drains to minimize water contact with manure. |
| | | | | | Odour masking | | | Cattle odour is considered less objectionable than hogs |
| Exsanguation | | Vacuum pump | High BOD (blood) | Washup and sanitation only | Proper layout of troughs required to minimize intrusion of blood into water stream. | | | Supervision and adequate training required to ensure appropriate post-operation cleanup. |
| | | | | | Post vacuum and squeegee of blood | | | |
| | | | | | Reuse upstream water for washup (refrigeration and vacuum pump water) | | | |
| Carcass Wash | | Electric drives for | BOD, solids | Variable - fresh potable water. | Recirculation to minimize water use. Requires screening, filtering, and in-line bacterial control. | Segregate/ screen/ filter for increased recycling | 8.2 | Manual operation in small plants, automatic system in larger plants. |
| | | | | | Two velocity fans for air during holding. | Air cycle refrigeration | 8.8 | Keep cooler floors and walls wet. |
| Sanitation (Washup) | | | | Variable, high water use - as much as 10-15% | Water temperature control valves (38-45 C) for foaming stage. | High pressure wash systems | 8.8 | Dry cleanup (squeegee, shovel, brooms), cold water flush, foaming, throughout cold potable rinse, disinfection, optional post-disinfection rinse. |
| | | | | | Automatic shut off valves on hoses during rinsing. | | | Proper concentrations of acid and alkaline cleaners important to ensure pH imbalance in effluents. |
| Trolley Wheel Wash | Hot caustic soak cycle 85 + C | | High potential pH in rinse overflow. | Continuous cold potable flow to wash immersion rinse | Ensure adequate drip time after caustic bath to reduce caustic carryover. Slow bleed out of rinse to ensure do not exceed effluent pH limits. | Use stainless straps and plastic wheels to eliminate requirement for caustic baths. | 8.9 | Wheel wash sequence: Hot caustic bath, drip-off, immersion in potable water wash, drip-off, lubricant oil spray. |
| | | | | | Flow control valve on immersion rinse to reduce unnecessary water overflow. | Air knife/blower to more rapidly/thoroughly remove caustic and water after baths. | Minor Equip | |
| | | | | | Temperature control on hot caustic bath heating | VSD on pull-through chain | 8.5 | |
| | | | | | Neutralize spent cautic bath prior to discharge | 7-day timers on soak bath cycles. | Minor Equip | |

* NOTE: tech reference refers to the Retrofit Opportunities Table 8

## TABLE 4: CHECK LIST OF IMPROVEMENT OPPORTUNITIES IN BEEF PROCESSING PLANT

| PROCESS AREA | CONCERNS | | | | OPERATING, LOW COST/NO COST | RETROFIT | TECH REF | COMMENTS |
|---|---|---|---|---|---|---|---|---|
| | Thermal | Power | Environment | Water | | | | |
| Barns, Assembly Pens and Chutes | Heating to above freezing | Ventilation | Odour, solids, BOD | Variable, mostly for washup. | Screening to separate solids in effluent | Air scrubber absorption beds for odour control | 8.1 | Proper slopes for troughs and drains to minimize water contact with manure |
| | | | | | Odour masking | | | Cattle odour is considered less objectionable than hogs |
| Exsanguination | | Vacuum pump | High BOD (blood) | Washup and sanitation only | Proper layout of troughs required to minimize intrusion of blood into water stream. | | | Supervision and adequate training required to ensure appropriate post-operation cleanup. |
| | | | | | Post vacuum and squeegee of blood | | | |
| | | | | | Reuse upstream water for washup (refrigeration and vacuum pump water) | | | |
| Carcass Wash (Calves only) | | Electric drives for automatic systems | BOD, solids | Variable - fresh potable water. Cold water, but could be warm if available | Recirculation to minimize water use. Requires screening, filtering, and in-line bacterial control | Segregate/ screen/ filter for increased recycling | 8.2 | Manual operation in small plants, automatic system in larger plants |
| | | | Blood, manure and urine major factors for BOD | | Shut-off valves for automatic systems. Self closing hose sprayers for manual operation. | In-line UV disinfection for reuse water. | 8.3 | |
| Work Stations and Knife Sterilization | High temp water 82 C for sterilization (2 & 3)<br>Warm rinse 38 C for hand wash | | BOD, grease and oil, solids | Potable water used. Typical constant overflow on sterilizers<br>Drain directly to sewer to comply with EEC requirements. (2 & 3) | Training and awareness of optimal water use to ensure hygenic standards | Foot, knee or waist activation or timing on wash flow | Minor Equip | Subjective reasoning on amount of water for rinsing. Often feel "more water is better" |
| | | | | | Flow and pressure regulation. | Proper spray nozzles to minimize water requirements. | Minor Equip | |
| Viscera Table | High temp water 82 C for rinses | Electrical or hydraulic drives | BOD, blood, grease, solids | Variable, three cycles - cold rinse - high temp sterilization - cold rinse | Ensure proper spray coverage of trays or slats to minimize water wastage | VSD and flow control valves to regulate water flow as line speed alters, to ensure carcass identity and hygiene standards | 8.4 | Cold rinse to minimize blood and protein bake on in pans |
| | | | | | Sequential timers and flow control valves | Spray type nozzles | Minor Equip | |
| | | | | | Monitor flow rates, pressure for minimum water, and maximum hygiene standards. | | | |
| Splitting Saw | High temp water 82 C for sterilization (2 & 3) | Electrical saw | BOD, grease, solids (bone dust) | Hot potable water to sterilize saw blade. | Solineoid cutoff valve on cold water rinse between carcasses. | | | Cascading of water from top of carcass down to bottom. |
| | | | | High pressure cold potable water for washing backbone vertabra | Ensure proper pressure and nozzle positioning to minimize rinse water wastage. | | | |
| By-product Water Chill/Wash (including heads) | | Can use chill water - refrig | BOD, blood, grease, minor solids | Cold potable water | Ensure proper agitation to minimize water requirements | | | Minimum water flow at moderate pressure |
| | | | | | Pressure regulation valves to control water flow | | | |
| Final Carcass Wash | | | BOD, grease | Cold potable water | Properly selected and positioned spray nozzles for cascading downward flow if automatic. | Solenoid valves to shut off between carcasses if automatic | Minor Equip | Cascading of water at moderate pressure from top of carcass down to bottom. |
| | | | | | Self closing hose sprayers for manual operation. Only wash carcass where required (e.g. back bone, chest cavity, neck, and front shanks) | | | |
| Shroud Washer | Warm water 38 C | Electrical powered washing machine | BOD, grease | Warm water, detergent wash followed by cold water rinses to cool. | Eliminate shroud use wherever possible (e.g. cows and carcasses designated for internal further processing) | Automatic timers on washing machine cycles. Flow control valves on rinse cycles | Minor Equip | Shrouding does not contribute to saving on carcass shrink, nor meat safety. Only important for visual appearance to satisfy certain customer preferences for smooth fat surfaces e.g. "eye appeal is buy appeal". |
| | | | | | Storage of washed shrouds overnight or weekends in mild saline, for bacterial control, reducing constant water overflow. Rinse in cold water prior to use. | | | |
| Chill Cooler (Hot Box) | | High refrig load | | | Use fluorescent lights in area to reduce heat input. | Air cycle refrigeration | 8.5 | Proper humidity required for quality and bloom (meat colour) |
| | | | | | Adequate temperature controls | | | Proper temperature difference required |
| | | | | | Minimize defrost cycles, large evaporative surface area, ample air velocity, minimum temperature differences to prevent condensation. | | | No or minimum defrost cycle during first 3 4 hours |
| Holding Cooler | | High refrig load | | | Reduce temperature differences using control valves on refrigerant system during carcass holding to reduce energy costs and shrinkage. | Free cooling during winter. | 8.7 | Proper humidity required for quality and bloom (meat colour). Minimum temperature difference required to minimize shrink |
| | | | | | Two velocity fans for air during holding | Air cycle refrigeration | 8.5 | Keep cooler floors and walls wet |
| Sanitation (Washup) | | | | Variable, high water use - as much as 10-18% | Water temperature control valves (38-45 C) for foaming stage. | High pressure wash systems | 8.8 | Dry cleanup (squeegee, shovel, brooms), cold water flush, foaming, throughout cold potable rinse, disinfection, optional post-disinfection rinse |
| | | | | | Automatic shut off valves on hoses during rinsing. | | | Proper concentrations of acid and alkaline cleaners important to ensure pH imbalance in effluents. |
| Trolley Wheel Wash | Hot caustic soak cycle 85+ C | | High potential pH in rinse overflow | Continuous cold potable flow to wash immersion rinse | Ensure adequate drip time after caustic bath to reduce caustic carryover. Slow bleed out of rinse to ensure do not exceed effluent pH limits. | Use stainless straps and plastic wheels to eliminate requirement for caustic baths | 8.9 | Wheel wash sequence: Hot caustic bath, drip-off, immersion in potable water wash, drip-off, lubricant oil spray |
| | | | | | Flow control valve on immersion rinse to reduce unnecessary water overflow. | Air knife/blower to more rapidly/thoroughly remove caustic and water after baths. | Minor Equip | |
| | | | | | Temperature control on hot caustic bath heating | VSD on pull-through chain | 8.6 | |
| | | | | | Neutralize spent cautic bath prior to discharge | 7-day timers on soak bath cycles | Minor Equip | |

* NOTE: tech reference refers to the Retrofit Opportunities Table 8

| PROCESS AREA | CONCERNS |  |  |  | OPERATING, LOW COST/NO COST | RETROFIT | TECH REF. | COMMENTS |
|---|---|---|---|---|---|---|---|---|
|  | Thermal | Power | Environment | Water |  |  |  |  |
| Barn and Squeeze Chutes | Heating to above freezing | Ventilation | Odour, solids, BOD, chlorine in scrubbers | Variable, mostly for washup. | Screening to separate solids in effluent | Air scrubber, absorption beds for odour control | 8.1 | Proper slopes for troughs and drains to minimize water contact with manure. |
|  |  |  |  |  | Odour masking |  |  |  |
| Exsanguation |  | Vacuum pump | High BOD (blood) | Washup | Proper layout of troughs required to minimize intrusion of blood into waste stream. Ensure proper blood holding capacity. | Filtration/fine screening to remove solids, hair for reuse. | 8.2 | Requires supervision to setup and monitor procedures upto and including foaming, rinsing and disinfecting. |
|  |  | Electrical or CO2 stunning |  |  | Post vacuum and squeegee of blood |  |  |  |
|  |  |  |  |  | Reuse hot water from scalding vat for initial rinse, requires screening/filtration. |  |  |  |
| Scald Vat | Hot water 80 C | High flow recirc pumps for agitation | Odour, BOD and solids (hair and toe nails), pH | Drag out of 2 L per hog from vat | Screening of water for solids separation. | Preheat make-up with hot effluent sources | 8.10 | Some steam injection required |
|  | Dwell time of 4 to 5 minutes |  | Blood major factor for BOD. |  | Cascade reuse water from dehairing as makeup (requires screening). | Segregate/ screen/ filter for increased recycling | 8.2 |  |
|  |  |  |  |  | Review layout and handling procedure to minimize blood intrusion into scalding (e.g. ensure adequate bleed time of 5 to 6 minutes) | VSD and flow control valves to regulate make-up water as line speed alters. | 8.4 |  |
|  |  | · refrig | solids |  | Pressure regulation valves to control water flow |  |  |  |
| Chilling and Holding Coolers |  | High refrig load |  |  | Reduce temperature differences using control valves on refrigerant system during carcass holding phase to reduce energy costs and shrinkage. | Free cooling during winter. | 8.7 | Proper humidity required for quality and bloom (meat colour) |
|  |  |  |  |  | Two stage fans to reduce air velocities during hold phase. | Air cycle refrigeration | 8.8 |  |
| Chilling and Holding Coolers |  | High refrig load |  |  | Reduce temperature differences using control valves on refrigerant system during carcass holding phase to reduce energy costs and shrinkage. | Free cooling during winter. | 8.7 | Proper humidity required for quality and bloom (meat colour) |
|  |  |  |  |  | Two stage fans to reduce air velocities during hold phase. | Air cycle refrigeration | 8.8 |  |
| Trolley Wheel Wash | Hot caustic soak cycle 85 + C |  | High potential pH in rinse overflow. | Continuous cold potable flow to wash immersion rinse | Ensure adequate drip time after caustic bath to reduce caustic carryover. Slow bleed out of rinse to ensure do not exceed effluent pH limits. | Use stainless straps and plastic wheels to eliminate requirement for caustic baths. | 8.9 | Wheel wash sequence: Hot caustic bath, drip-off, immersion in potable water wash, drip-off, lubricant oil spray. |
|  |  |  |  |  | Flow control valve on immersion rinse to reduce unnecessary water overflow. | Air knife/blower to more rapidly/thoroughly remove caustic and water after baths. | Minor Equip |  |
|  |  |  |  |  | Temperature control on hot caustic bath heating | VSD on pull-through chain | 8.5 |  |
|  |  |  |  |  | Neutralize spent cautic bath prior to discharge | 7-day timers on soak bath cycles. | Minor Equip |  |
| Sanitation (Washup) |  |  |  | Variable, high water use - as much as 10-15% | Water temperature control valves (38-45 C) for foaming stage. | High pressure wash systems | 8.8 | Dry cleanup (squeegee, shovel, brooms), cold water flush, foaming, throughout cold potable rinse, disinfection, optional post-disinfection rinse. |
|  |  |  |  |  | Automatic shut off valves on hoses during rinsing. |  |  | Proper concentrations of acid and alkaline cleaners important to ensure pH imbalance in effluents. |

* NOTE: tech reference refers to the Retrofit Opportunities Table 8

## TABLE 5: CHECK LIST OF IMPROVEMENT OPPORTUNITIES IN HOG PROCESSING PLANT

| PROCESS AREA | CONCERNS | | | | OPERATING, LOW COST/NO COST | RETROFIT | TECH REF. | COMMENTS |
|---|---|---|---|---|---|---|---|---|
| | Thermal | Power | Environment | Water | | | | |
| Barn and Squeeze Chutes | Heating to above freezing | Ventilation | Odour, solids, BOD, chlorine in scrubbers | Variable, mostly for washup. | Screening to separate solids in effluent | Air scrubber,absorption beds for odour control | 8.1 | Proper slopes for troughs and drains to minimize water contact with manure |
| | | | | | Odour masking | | | |
| Exsanguination | | Vacuum pump | High BOD (blood) | Washup | Proper layout of troughs required to minimize intrusion of blood into waste stream. Ensure proper blood holding capacity. | Filtration/line screening to remove solids, hair for reuse. | 8.2 | Requires supervision to setup and monitor procedures upto and including foaming, rinsing and disinfecting |
| | | Electrical or CO2 stunning | | | Post vacuum and squeegee of blood | | | |
| | | | | | Reuse hot water from scalding vat for initial rinse, requires screening/filtration. | | | |
| Scald Vat | Hot water 60 C | High flow recirc pumps for agitation | Odour, BOD and solids (hair and toe nails), pH | Drag out of 2 L per hog from vat | Screening of water for solids separation. | Preheat make-up with hot effluent sources | 8.10 | Some steam injection required |
| | Dwell time of 4 to 5 minutes | | Blood major factor for BOD. | | Cascade reuse water from dehairing as makeup (requires screening). | Segregate/ screen/ filter for increased recycling | 8.2 | |
| | | | | | Review layout and handling procedure to minimize blood intrusion into scalding (e.g. ensure adequate bleed time of 6 to 8 minutes) | VSD and flow control valves to regulate make-up water as line speed alters. | 8.4 | |
| Dehairing | Hot water 55 C on initial | Mechanical action - high energy use | Odour, BOD and solids (hair and toe nails) | | Recycle outlet flow back to scald | VSD and flow control valves to regulate water flow as line speed alters. | 8.4 | Rate of kill, dwell time, and temperature are critical for maintenance of product quality |
| | | Recirc pump | | Hot water on initial 3/4dehairing Cold potable rinse for last 1/4 at discharge end | | Preheat water makeup with singe air exhaust stack using CHR or indirect contact | 8.11 | |
| | | Scrapper screen to separate solids | | | | | | |
| Singeing | High Nat Gas consumption - 0.4-0.8 m3 per hog | Air blowers | Odour, particulate emissions | | Solenoid switches to regulate gas flow/flame with line speed. | CHR or exhaust scrubbing to reduce air emissions. | 8.11 | |
| | | | | | Control to flame only when carcasses pass through | Potential good match for CHR to heat sinks for dehairing requirements. | | |
| Carcass Showers | | | BOD, solids (hair) | Highly variable | Regulate water flow to carcass throughput travel | Spray type nozzles. | Minor Equip | |
| | | | | Potable water, either cold or may be warmed | Shutoff valves for when line stops | VSD and flow control valves to regulate water flow as line speed alters. | 8.4 | |
| | | | | Water typically direct to sewer. | Spray nozzle type and positioning to ensure coverage of entire carcass. | | | |
| Work Stations and Knife Sterilization | High temp water 82 C for sterilization (2.8.3)<br>Warm rinse 38 C for hand wash | | BOD, grease and oil | Potable water used. Typical constant overflow on sterilizers | Training and awareness of optimal water use to ensure hygenic standards. | Foot, knee or waste activation or timing on wash flow. | Minor Equip | Subjective reasoning on amount of water for rinsing. |
| | | | | Drain directly to sewer to comply with EEC requirements. (2.8.3) | Flow and pressure regulation. | Proper spray nozzles to minimize water requirements. | Minor Equip | |
| Viscera Table | High temp water 82 C for rinses | Electrical or hydraulic drives. | BOD, blood, grease, solids | Variable three cycles - cold rinse - high temp sterilization - cold rinse | Ensure proper spray coverage of trays or slats to minimize water wastage | VSD and flow control valves to regulate water flow as line speed alters, to ensure carcass identity and hygiene standards | 8.4 | Cold rinse to minimize blood and protein bake-on in pans |
| | | | | | Sequential timers and flow control valves | Spray type nozzles | Minor Equip | |
| | | | | | Monitor flow rates. pressure for minimum water, and maximum hygiene standards. | | | |
| Splitting Saw | High temp water 82 C for sterilization (2.8.3) | Electrical saw | BOD, grease, solids (bone dust) | Hot potable water to sterilize saw blade. | Solineoid cutoff valve on cold water rinse between carcasses. | | | Cascading of water from top of carcass down to bottom. |
| | | | | High pressure cold potable water for washing backbone vertebra | Ensure proper pressure and nozzle positioning to minimize rinse water wastage. | | | |
| Final Carcass Wash | | | BOD, grease | Cold potable water | Propery selected and positioned spray nozzles. | Solenoid valves to shut off between carcasses | Minor Equip | Cascading of water at moderate pressure from top of carcass down to bottom. |
| | | | | | | Potential for water recirculation with water chill and in-line UV bacterial control, to more efficiently cool carcasses prior to chill cooler. | 8.3 | |
| By-product Water Chill | | Can use chill water - refrig | BOD, blood, grease, minor solids | Cold potable water | Ensure proper agitation to minimize water requirements | | | Minimum water flow at moderate pressure |
| | | | | | Pressure regulation valves to control water flow | | | |
| Chilling and Holding Coolers | | High refrig load | | | Reduce temperature differences using control valves on refrigerant system during carcass holding phase to reduce energy costs and shrinkage. | Free cooling during winter. | 8.7 | Proper humidity required for quality and bloom (meat colour) |
| | | | | | Two stage fans to reduce air velocities during hold phase. | Air cycle refrigeration | 8.8 | |
| Chilling and Holding Coolers | | High refrig load | | | Reduce temperature differences using control valves on refrigerant system during carcass holding phase to reduce energy costs and shrinkage. | Free cooling during winter. | 8.7 | Proper humidity required for quality and bloom (meat colour) |
| | | | | | Two stage fans to reduce air velocities during hold phase. | Air cycle refrigeration | 8.8 | |
| Trolley Wheel Wash | Hot caustic soak cycle 85 + C | | High potential pH in rinse overflow. | Continuous cold potable flow to wash immersion rinse | Ensure adequate drip time after caustic bath to reduce caustic carryover. Slow bleed out of rinse to ensure do not exceed effluent pH limits. | Use stainless straps and plastic wheels to eliminate requirement for caustic baths. | 8.9 | Wheel wash sequence: Hot caustic bath, drip-off, immersion in potable water wash, drip-off, lubricant oil spray. |
| | | | | | Flow control valve on immersion rinse to reduce unnecessary water overflow. | Air knife/blower to more rapidly/thoroughly remove caustic and water after baths. | Minor Equip | |
| | | | | | Temperature control on hot caustic bath heating | VSD on pull-through chain | 8.5 | |
| | | | | | Neutralize spent cautic bath prior to discharge | 7-day timers on soak bath cycles | Minor Equip | |
| Sanitation (Washup) | | | | Variable, high water use - as much as 10-15% | Water temperature control valves (38-48 C) for foaming stage. | High pressure wash systems | 8.6 | Dry cleanup (squeegee, shovel, brooms), cold water flush, foaming, throughout cold potable rinse, disinfection, optional post-disinfection rinse |
| | | | | | Automatic shut off valves on hoses during rinsing. | | | Proper concentrations of acid and alkaline cleaners important to ensure pH imbalance in effluents. |

* NOTE tech reference refers to the Retrofit Opportunities Table 6

# TABLE 6: CHECK LIST OF IMPROVEMENT OPPORTUNITIES IN POULTRY PROCESSING PLANT

| PROCESS AREA | CONCERNS |  |  |  | OPERATING, LOW COST/NO COST | RETROFIT | TECH REF. | COMMENTS |
|---|---|---|---|---|---|---|---|---|
|  | Thermal | Power | Environment | Water |  |  |  |  |
| Receiving and Coop Wash |  | Recirc pump | BOD, solids, odour, loose feathers | Large water use, but can be highly variable | Reuse water from less contaminated upstream areas for initial coop wash | Fine screening and filtering of reuse water prior to pump to reduce suspended solids. Reduces down stream waste load, and improves cleaning efficiency of reuse water.. | 8.2 | 1. Coops can be very contaminated.<br>2. First 1/3 to 1/2 Rinse requires copious amounts of water, to remove dried feathers and feces. |
|  |  |  |  | Cold water, but can be warm | Use potable water only for final wash, rinse and disinfection |  |  | 3. Cold weather can prevent washing operation. |
|  |  |  |  | Dependent on weather |  |  |  | This is the most contaminated location in plant. |
| Exsanguation and Bleed Trough/Tunnel |  | Vacuum pump | BOD (blood) | Fairly small use for stun and guide bar sprays | Proper layout of troughs required to minimize intrusion of blood into waste stream. | Use same reuse water system as above for initial washing. | 8.2 | Requires supervision to setup and monitor procedures upto and including foaming, rinsing and disinfecting. |
|  |  |  |  | 0.1 to 0.2 L/bird | Post vacuum and squeegee of blood |  |  |  |
|  |  |  |  | Washup | Reuse water from less contaminated upstream areas for initial wash. Need to avoid hot water. |  |  |  |
| Scald Vat | Hot water 60 C | High flow recirc pumps for | BOD and fat in effluent | Large water use, 0.75 L/bird dragout plus | Minimize water addition to replacement of dragout to reduce unnecessary overflow. | Preheat make-up with hot effluent sources | 8.10 | Some steam injection required |
|  |  |  |  |  |  |  |  | increase effectiveness [illegible]<br>techniques.<br>Rotation of acid/alkaline cleaners as required. |
| Working Rooms |  | Refrig |  |  |  | Free Cooling | 8.7 |  |

* NOTE: tech reference refers to the Retrofit Opportunities Table 8

# TABLE 8: CHECK LIST OF IMPROVEMENT OPPORTUNITIES IN POULTRY PROCESSING PLANT

| PROCESS AREA | CONCERNS | | | | OPERATING, LOW COST/NO COST | RETROFIT | TECH REF | COMMENTS |
|---|---|---|---|---|---|---|---|---|
| | Thermal | Power | Environment | Water | | | | |
| Receiving and Coop Wash | | Recirc pump | BOD, solids, odour, loose feathers | Large water use, but can be highly variable<br>Cold water, but can be warm<br>Dependent on weather | Reuse water from less contaminated upstream areas for initial coop wash<br>Use potable water only for final wash, rinse and disinfection | Fine screening and filtering of reuse water prior to pump to reduce suspended solids. Reduces down stream waste load, and improves cleaning efficiency of reuse water.. | 8.2 | 1. Coops can be very contaminated<br>2. First 1/3 to 1/2 Rinse requires copious amounts of water, to remove dried feathers and feces<br>3. Cold weather can prevent washing operation.<br>This is the most contaminated location in plant. |
| Exsanguation and Bleed Trough/Tunnel | | Vacuum pump | BOD (blood) | Fairly small use for stun and guide bar sprays<br>0.1 to 0.2 L/bird<br>Washup | Proper layout of troughs required to minimize intrusion of blood into waste stream.<br>Post vacuum and squeegee of blood<br>Reuse water from less contaminated upstream areas for initial wash. Need to avoid hot water. | Use same reuse water system as above for initial washing. | 8.2 | Requires supervision to setup and monitor procedures upto and including foaming, rinsing and disinfecting |
| Scald Vat | Hot water 80 C | High flow recirc pumps for agitation | BOD and fat in effluent<br>Blood major factor for BOD. | Large water use, 0.78 L/bird dragout plus overflow | Minimize water addition to replacement of dragout to reduce unnecessary overflow.<br>Cascade reuse water from upsteam defeathering and/or whole bird wash to scald as makeup if necessary.<br>Review layout and bird handling procedure to minimize blood intrusion into scalding (e.g. ensure adequate bleed time by addition travel time on chain) | Preheat make-up with hot effluent sources<br>Segregate/ screen/ filter for increased recycling<br>In-line UV bacterial control<br>VSO and flow control valves to regulate make-up water as line speed alters. | 8.10<br>8.2<br>8.3<br>8.4 | Some steam injection required<br>In-line pH meter may be required<br>High-intensity UV required |
| Defeathering | Hot water, lower than scald | Mechanical action on whips<br>Recirc pump<br>Roto or vibre screen to separate solids | BOD, solids, odour and grease | 1.0 to 2.0 L/bird | Recycle outlet flow back to scald<br>Cascade reuse water from whole bird wash upstream as makeup<br>If cannot reuse this water, use in heat exchange to preheat scald makeup. | VSO and flow control valves to regulate water flow as line speed alters. | 8.4 | Roto-screen and filter water as soon as possible to minimize load of blood/BOD in reuse water. |
| Whole Bird Wash | | Screen feathers and solids, grease<br>Recirc pump | BOD, grease, and feathers | 0.8 to 3.0 L/bird rinse<br>Cold water, heats up as contacts warm birds | Ensure water pressure is optimized.<br>Review type and positioning of spray nozzles. | VSO and flow control valves to regulate make-up water as line speed alters. | 8.4 | Copious quantities of water at lower pressure (25-50 psig) flow water needed during initial stages to provide satisfactory wash.<br>Avoid water pressure extremes. Do not want penetration of skin by foreign materials, i.e. feather particles, solids, etc.<br>Positioning of nozzles critical for complete washing of birds |
| Evisceration | | Recirc pumps<br>Screens<br>Vacuum Pumps Automatic Equipment | BOD, grease (oil sacks) | 2.0 to 8.0 L/bird<br>Cold water<br>Water to viscera flume | Training and awareness of optimal water use to ensure hygenic standards. | Knee activation valves.<br>VSO and flow control valves to regulate water flow as line speed alters.<br>Spray type nozzles.<br>Dry evisceration. | Minor Equip<br>8.4<br>Minor Equip | Subjective reasoning on amount of water for rinsing. Often feel "more water is better".<br>Minimum contact between viscera and water reduces loading in wastewater. |
| Giblet, Heart, Liver Station | | Vacuum, pump, or flume<br>Chilled water - refrig | BOD, blood, grease | 2.0 to 3.0 L/bird cold or chilled<br>Downstream equipment and layout critical to process<br>Water to viscera flume | Training and awareness of optimal water use to ensure hygenic standards.<br>Reduce chill water to hearts/livers and gizzards to minimum. | VSO and flow control valves to regulate water flow as line speed alters. | 8.4 | |
| Final Bird Wash | | Recirc pump | BOD, blood, grease | 0.7 to 0.8 L/bird<br>Water to viscera flume | Ensure water pressure is optimized.<br>Review type and positioning of spray nozzles.<br>Monitor flow rates, pressure for minimum water, and maximum hygiene standards. | VSO and flow control valves to regulate water flow as line speed alters.<br>Spray type nozzles | 8.4<br>Minor Equip | Monitor flow rates pressure for minimum water, and maximum hygiene standards. |
| Immersion Chillers | | Chilled water 1-2 Refrig | BOD, blood, grease, solids | 0.1 to 0.2 L/bird dragout<br>1.8 to 2.2 L/bird | Minimize makeup to reduce excess overflow | In-line UV bacterial control<br>Ice in lieu of makeup<br>Membrane processing of cold water, cold permeate to recycle, concentrate to viscera flume. | 8.3<br>8.12 | Water cascade from chiller to prechiller is typical.<br>U.S. controls for makeup water/ice Option appropriate only if chiller capacity is insufficient. |
| Sanitation (Washup) | Warm potable water | | BOD, solids, grease | 6.0 to 10.0 L/bird | Update to maintain superior hygiene standards.<br>Reduce water, energy detergent, disinfectant costs. | HP systems required for low temp washing | 8.8 | Supervision, trening.<br>Dry clean - i.e. vacuum, squeegee blood, solids, reduce costs of detergents.<br>Increase effectiveness by using proper foam techniques.<br>Rotation of acid/alkaline cleaners as required. |
| Working Rooms | | Refrig | | | | Free Cooling | 8.7 | |

* NOTE: tech reference refers to the Retrofit Opportunities Table 8

## TABLE 7: CHECK LIST OF IMPROVEMENT OPPORTUNITIES IN EDIBLE/INEDIBLE RENDERING PLANT

| PROCESS AREA | CONCERNS | | | | OPERATING, LOW COST/NO COST | RETROFIT | TECH REF. | COMMENTS |
|---|---|---|---|---|---|---|---|---|
| | Thermal | Power | Environment | Water | | | | |
| Receiving | Hot water for washup | Electric drives for auger feeders and machinery. | Odour, contaminated free liquid drainage with high BOD, solids | Variable, mostly for washup. | Screening to separate solids in effluent | Air scrubber,absorption beds for odour control | 8.1 | Rapid processing of raw material important to minimize odour and free fatty acids. |
| Grinding (excluding chicken offal and feathers) | | High electrical equipment , grinding | Odour, washup BOD and solids | Variable, mostly for washup. | Proper material control to prevent spills. | VSD systems | 8.4 | |
| Feed to Cooker | Steam if steam blow tank | Mechanical drive and air blow | Odour, solids, fats and grease | Variable, mostly for washup. | Automatic shutoff of feeder and/or sensors to indicate transfer blockages or cooker overfills | Blow tank systems are environmentally preferred for all materials except feather. System more enclosed to atmosphere. | | Mechanical augers or belts, or steam or air blow tank feeding of cookers |
| Cooker | High thermal energy | High electrical inputs for agitation | Condensing vapours - high odour from cooked material | High water usage for vapour condensation | Humidistat control (blood), high temperature controls to prevent overcooking, and end point controls. | | | Overcooking produces significant fines, which are difficult to dispose. |

## TABLE 7: CHECK LIST OF IMPROVEMENT OPPORTUNITIES IN EDIBLE/INEDIBLE RENDERING PLANT

| PROCESS AREA | CONCERNS | | | | OPERATING, LOW COST/NO COST | RETROFIT | TECH REF. | COMMENTS |
|---|---|---|---|---|---|---|---|---|
| | Thermal | Power | Environment | Water | | | | |
| Receiving | Hot water for washup | Electric drives for auger feeders and machinery. | Odour, contaminated free liquid drainage with high BOD, solids | Variable, mostly for washup. | Screening to separate solids in effluent | Air scrubber,absorption beds for odour control | 8.1 | Rapid processing of raw material important to minimize odour and free fatty acids |
| Grinding (excluding chicken offal and feathers) | | High electrical equipment, grinding | Odour, washup BOD and solids | Variable, mostly for washup. | Proper material control to prevent spills. | VSO systems | 8.4 | |
| Feed to Cooker | Steam if steam blow tank | Mechanical drive and air blow | Odour, solids, fats and grease | Variable, mostly for washup. | Automatic shutoff of feeder and/or sensors to indicate transfer blockages or cooker overfills | Blow tank systems are environmentally preferred for all materials except feather System more enclosed to atmosphere | | Mechanical augers or belts, or steam or air blow tank feeding of cookers |
| Cooker | High thermal energy | High electrical inputs for agitation | Condensing vapours - high odour from cooked material<br>Material discharge - high odour | High water usage for vapour condensation<br>Production of significant additional contaminated water (condensed product vapour) | Humidistat control (blood), high temperature controls to prevent overcooking, and end point controls. | | | Overcooking produces significant fines, which are difficult to dispose |
| Percolating Box | | Electrical drives e.g. to augers | Material discharge - high odour<br>Sterile material | | | Enclose and vent to scrubbers | 8.1 | |
| Oil Recovery:<br>Expeller<br>Hydraulic Press<br>Solvent Extraction<br>Basket Centrifuge | | Electrical drives. | Odour, Dangerous chemical if solvent extraction | | Avoid spills of fluids or solids | | | Solvent extraction (usually heptane) not common in Canada, however, used in Europe and U.S. |
| Dryer Typically for poultry, e.g. feathers | High thermal energy | Electrical drives. | Odour | High water usage for vapour condensation<br>Production of significant additional contaminated water (condensed product vapour) | Humidistat controls | | | |
| Oil Processing - Centrifugation and Washing | | Centrifuge | Ejected sludge if not returned to cooker.<br>Spent TSP if not returned to cooker | | Maintain optimum tallow flow rates to ensure proper centrifuge performance | | | |
| Scrubbing | | Blowers and fans | Chlorine/ClO2 scrubbing for odour control | Water input to wet scrubbing systems | | Bioscrubbers, biomaterial | 8.1 | Combustible non-condensible vapours burned in boiler, rather than scrubbing |
| Water treatment | | Treatment e.g. Aeration | Sludges, odour, alkaline pH effluent | Produced water removed from input product | Temperature control, equalization backup reservoir, power backup<br>Biological treatment controls | | | |

* NOTE: tech reference refers to the Retrofit Opportunities Table 8

## TABLE 8: CHECK LIST OF RETROFIT OPTIONS IN MEAT AND POULTRY PROCESSING

| REF NO. | RETROFIT | EQUIPMENT | COSTS | SAVINGS | PAYBACK | COMMENTS/ BENEFITS |
|---|---|---|---|---|---|---|
| 8.1 | Odour Control | Biological Scrubbers Absorption Beds | 30-300k | 6-90k | 3-5 yrs | Alternative to chemical scrubbers with associated chemical release concerns. Chemical, water and electrical savings result. |
| 8.2 | Removal of Suspended Solids Matter in Reuse Water | Screens or Filters | 5-80k | 5-20k | 1-4 yrs | Reuse of water reduces fresh water consumption, and heating/cooling costs. Screens less costly, but less effective than filters in general. |
| 8.3 | In-Line Bacterial Control | High Intensity UV Lamps | 60-100k | 20-80k | 1-3 yrs | Disinfection without affecting temperature, allows reuse of water. Especially advantageous for low temperature water. |
| 8.4 | VSD on water flows for kill rate change | Variable speed drive | 5-20k | 5-20k | 1 yrs | Reduction - Saves water, gas, power, effluent No quality or sanitation concern |
| 8.5 | VSD on pull-through | Variable speed drive | 5-10k | 5-10k | 1-2 yrs | Reduction - Saves water, gas, power, effluent No quality or sanitation concern |
| 8.6 | Product Refrigeration | Air Cycle Refrigeration |  |  | 2-3 yrs | Costs are 10-15% higher than standard refrigeration, but 50% lower than cryogenic freezing. |
| 8.7 | Holding Coolers, and Refrigerated Work Areas | Free Cooling | 5-20k | 5-20k | 1-2 yrs |  |
| 8.8 | Sanitation/Washup | High Pressure Wash System | 2-50k | 5-20k | 0.5-2 yrs | Labour, detergent, santizing agents |
| 8.9 | Trolley System | Plastic Wheels and Stainless Steel Straps and Hooks | 30-300k | 2-10k | 5+ yrs | Long payback on operating savings, but reduced caustic use may help avoid pH treatment for compliance. |
| 8.10 | Preheat make-up with effluent | Plate, spiral heat exchanger | 30-100k | 10-50k | 1.5-3 yrs | Heat recovery - should be last to implement Prescreening may be required. |
| 8.11 | Hot Air Exhaust Heat Recovery | Condensing Heat Recovery - Direct or Indirect Contact | 10-80k | 2-25k | 2.5-5 yrs | Direct contact recovery also provides scrubbing for odour control. |
| 8.12 | Immersion Chiller Recycle | Membrane Technology | 20-80k | 15-60k | 1-2 yrs | Heat recovery - should be last to implement Prescreening may be required |

# TABLE 9: CHECK LIST OF IMPROVEMENT OPPORTUNITIES IN UTILITIES AND SERVICES

| PROCESS AREA | CONCERNS |  |  |  | OPERATING, LOW COST/NO COST | RETROFIT | TECH REF. | COMMENTS |
|---|---|---|---|---|---|---|---|---|
|  | Thermal | Power | Environment | Water |  |  |  |  |
| Cold Water |  |  |  | Variable, for process, washup and utility cooling. | Water meters in different process areas to monitor consumption on a on-going basis. | Closed loop cooling systems | 10.1 |  |
|  |  |  |  |  | Recycle once-though cooling water to process or other uses. |  |  |  |
| Hot Water |  |  |  | Variable, for washup and process. | Insulate HW tanks and lines, and hot process vessels. | Direct contact water heaters for non-sensitive hot water e.g. scalding or first sanitation washup. | 10.2 |  |
|  |  |  |  |  | Ensure appropriate water heater set points. | Hot water tanks/heaters rather than boiler if no cooking or smoking operations. | 10.3 |  |
|  |  |  |  |  | Recover water from utility cooling such as vacuum pump or refrigeration compressor. | Segregate HW systems to reduce unnecessary heating. | 10.4 |  |
| Steam | Natural gas typical. |  | Boiler emissions |  | Tune boiler combustion air to achieve optimum fuel/air mixture | Economizer on boiler. | 10.5 |  |
|  |  |  |  |  | Use interruptible gas service at lower cost, if appropriate. | Flue gas heat recovery, or direct contact condensing heat recovery. | 10.6 |  |
|  |  |  |  |  | Blow down heat recovery (heating washup water, boiler feed water, etc.) | Smaller jockey boiler for summer period (to reduce overcapacity) | 10.8 |  |
|  |  |  |  |  | Identify and correct steam leaks. | Heat exchange for water heating, rather than injection (tanks and mixing valves) | 10.7 |  |
|  |  |  |  |  | Insulate steam and condensate return lines. | Replace boiler with hot water heaters. | 10.3 |  |
|  |  |  |  |  | Trap Maintenance<br>Monitor steam consumption, to avoid surges. |  |  |  |
| Natural Gas (direct) |  |  | Emissions |  | Use interruptible gas service at lower cost, if appropriate. | Flue gas heat recovery, or direct contact condensing heat recovery. | 10.6 |  |
|  |  |  |  |  | Automatic shutoff when not required. |  |  |  |
| Refrigeration |  | High electrical inputs |  | Cooling water | Schedule refrigeration compressors to reduce electrical peak demand. | Segregation of refrigeration system according to temperature | 10.9 |  |
|  |  |  |  |  | Insulate cold process areas to reduce summer refrigeration load | Free Cooling | 10.10 |  |
|  |  |  |  |  | Clean evaporators and condensers | Absorption Cooling | 10.11 |  |
|  |  |  |  |  | Insulate refrigerant lines<br>Reduce infiltration in cold rooms<br>Reduce refrigeration defrost cycle periods |  |  |  |
| Compressed Air |  | Electrical drives |  |  | Analyze for air leaks and repair. | Engine driven systems | 10.12 | Ultrasonic detection equipment available. |
| Electrical (Direct Uses) |  | Electrical drives. |  |  | Reduce unnecessary lighting/replace with higher efficiency lights | Power factor correction to reduce surcharge | 10.13 |  |
|  |  |  |  |  |  | High Efficiency Drive Motors | 10.14 |  |

* NOTE: tech reference refers to the Retrofit Opportunities Table 10

## TABLE 10: CHECK LIST OF RETROFIT OPTIONS IN UTILITIES AND SERVICES

| REF NO. | RETROFIT | EQUIPMENT | COSTS | SAVINGS | PAYBACK | COMMENTS/ BENEFITS |
|---|---|---|---|---|---|---|
| 10.1 | Cooling Water | Closed Loop Cooling Systems | 25-100k | 15-50k | 0.5-2 yrs | |
| 10.2 | Hot Water | Direct Contact HW Heater (Bed or Immersion) | 20-50k | 8-20k | 1-3 yrs | |
| 10.3 | Hot Water | Change boiler to HW heaters | 50-200k | 10-50k | 1-5 yrs | |
| 10.4 | Hot Water | Segregating HW system | 10-30k | 5-15k | 2-4 yrs | |
| 10.5 | Steam | Economizer on Boiler. | 10-30k | 3-15k | 3-5 yrs | |
| 10.6 | Steam | Flue gas heat recovery, condensing heat recovery | 50-100 | 15-40k | 2-4 yrs | |
| 10.7 | Steam | Heat Exchange instead of injection | 10-50k | 5-15k | 2-3 yrs | |
| 10.8 | Steam | Jockey Boiler for Summer | 50-100k | 30-50k | 1-2 yrs | |
| 10.9 | Refrigeration | Segregation of Refrigeration Systems according to temperature | 30-40k | 15-30k | 1-2 yrs | |
| 10.10 | Refrigeration | Free Cooling (during Winter) | 50-150k | 20-80k | 1-3 yrs | |
| 10.11 | Refrigeration | Absorption Cooling | 200-500k | 100-300k | 1-2 yrs | |
| 10.12 | Compressed Air | Engine Driven Systems | 20-80k | 5-20k | 3-5 yrs | |
| 10.13 | Electrical | Power Factor Correction | 20-80k | 15-60k | 1-2 yrs | |
| 10.14 | Electrical | High Efficiency Drive Motors | 100-200k | 30-100k | 2-3 yrs | Rebate program available from Ontario Hydro to reduce capital cost of conversions. |

In addition to the low-cost/no-cost and retrofit technology opportunities, it is important to consider opportunities associated with management practices, training and awareness, advanced analysis methods, and cooperative actions with producers:

- Management commitment to energy/environment. An effective energy management and pollution prevention program must have the endorsement of top level management. A clear commitment by management is essential to achieving financial, image and societal benefits through pollution prevention. Participation in programs such as Ontario's Pollution Prevention Pledge Program, could galvanize employee action and accomplish significant cost reductions. These should be considered by management.

- In-plant training and awareness of energy/environment. In meat and poultry processing plants, operators often have significant discretion over the quantities of water, chemicals, and energy consumed as they perform their tasks. Plant personnel should be trained in operational techniques that will result in cost reduction and environmental improvements.

- Advanced analysis methods. Often, a holistic approach to analyzing pollution prevention and energy use reduction is essential in complex processes. An example is Energy Process Integration, or *Pinch*, that was recognized to be an important tool by the industry in a recent food industry sector technology study, sponsored by Natural Resources Canada. A write up on this technology is included in Appendix F.

- Cessation of feeding of animals prior to slaughter. Cessation of feeding the animal (except water) for 8 to 24 hours prior to slaughter, has been shown in Europe to be less stressful for the animals, and does not cause eviscerated/dressed carcass weight loss. It offers significant meat hygiene and food safety benefits, and can save feeding costs for producers. In addition, it results in a significant reduction in the quantity of undigested contents, which is an environmental problem faced by the industry. Cooperation between producers and processors to ensure consistent practices in this regard offers mutual environmental benefits.

## 5.0 NEW TECHNOLOGIES

New technologies relevant to energy efficiency and pollution prevention in meat and poultry processing are summarized in Table 11. A total of twelve generic technologies have been identified. All these technologies are likely to be applicable within the next 5 to 10 years. They are either currently being researched and developed or, if commercially available, are not being used in Ontario.

It is important to note that this table is not comprehensive and is only a starting point for site specific evaluations. A wide variety of new technologies are under development or implementation, which relate to productivity improvement. Any such technologies with little or no impact on pollution prevention or energy savings have been excluded from Table 11.

# TABLE 11: NEW TECHNOLOGIES FOR MEAT AND POULTRY PROCESSING

| REF NO. | NAME OF TECHNOLOGY | DESCRIPTION OF TECHNOLOGY | APPLICATION | |
|---|---|---|---|---|
| | | | ANIMAL | PROCESS |
| 11.1 | Expert Computer Control Systems | | | |
| | | Refrigeration Control | Beef, Poultry, Hogs | Cooling |
| | | Manufacturing Controls (Especially linked to water use) | Beef, Poultry, Hogs | Processing |
| | | Environmental Controls | All | |
| 11.2 | Semi-Permeable Membrane Technology | Recovery of solubles and solids, and recycle of water. Barriers allow technology to easily meet water reuse criteria in regulations. Implementation now economically determined. Few other barriers. | Beef, Poultry, Hogs | Water recycle. |
| 11.3 | Superheated Steam Drying | High efficiency drying method, allows reuse of recovered evaporation as useful steam. | Rendering | Drying |
| 11.4 | Microwave Assisted Heating | Edible rendering and heating/cooking applications in further processing | Rendering and Beef, Poultry Hogs | Edibles Cooking |
| 11.5 | Radio Frequency Assisted Heating | Heating cooking applications | Beef, Poultry, Hogs | Cooking |
| 11.6 | Ohmic Heating | Heating cooking applications | Beef, Poultry, Hogs | Cooking |
| 11.7 | Advanced High-rate Anaerobic Wastewater Treatment | Advanced treatment technologies to achieve improved performance, reduce effluent loading and reduced emissions. | All | |
| 11.8 | Biodegradable or Natural Weiner Casing | Addressing problem with accumulation of large quantities of casings generated. | Beef and Hogs | Processed Meats |
| 11.9 | Mechanical Separation/Evaporation Systems for Water Removal | Reduction of energy requirements for rendering | Rendering | |
| 11.10 | Immersion Chilling of Vacuum Package Cuts | Efficient cooling by liquid media rather than air. | All | Processed Meats |
| 11.11 | Immersion Prechilling of Hogs | Efficient cooling by liquid media rather than air. | Hogs | |
| 11.12 | Dry Evisceration Systems | Not new approach, but has significant advantages in water reduction. Not used extensively in Ontario. | Poultry (primarily) | |

# 6.0 RELEVANCE TO OTHER INDUSTRIES

The process-focused approach used in this study is valid for identifying opportunities in all process industries. The low-cost, no-cost, operational and retrofit opportunities are based on the principles of pollution prevention. A number of these could be effectively used by other industries but are most relevant to the food and beverage industry for the following reasons:

- Product characteristics;
- Importance of regulations and emphasis on microbial control and sanitation for maintenance of product quality;
- Significant water consumption;
- Hot water and refrigeration requirements; and
- Environmental issues.

The priority food and beverage industries, where this work is likely to be of greatest relevance include:

- Vegetable and fruit;
- Confectionary;
- Dairy;
- Brewing; and
- Soft drinks and other beverages.

Of the various retrofit and new technologies identified it is the generic technologies such as membrane separation for water and solids recovery and high intensity ultraviolet treatment for microbial control in process water streams, which would find an increasing use throughout the food industry. These technologies offer multiple benefits and could contribute to a significant reduction in effluent treatment costs in most industries.

# 7.0 CONCLUSIONS AND RECOMMENDATIONS

Our work has shown that there are significant opportunities for energy and water use reduction, and environmental improvement in the meat and poultry sector. We have presented information on these opportunities in a logical, easy-to-read manner, with the objective of facilitating use by industry personnel and consultants.

We recommend that:

- ► The check lists prepared be used as a starting point for plant specific assessments.
- ► The process-focused methodology employed in this study, and the generic opportunities that have been identified should be applied to other sectors, especially in the food and beverage industry.
- ► Additional work needs to be done in collecting and compiling accurate water use data, because of the potential for reasonable cost savings and conservation opportunities.

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# APPENDIX A

# APPENDIX A

# PROJECT TERMS OF REFERENCE

# TERMS OF REFERENCE

# FOR A SECTOR STUDY ON MEAT AND POULTRY PRODUCTS INDUSTRIES

## I. OBJECTIVES:

The purpose of this assignment is to provide the Industry Programs Branch (IPB) of the Ministry of Environment and Energy (MOEE) with a clear, concise document outlining 5 main topics as explained in **III. Scope**, on the Meat and Poultry Products Industries of the Food Sector, based in Ontario.

This document will form the basis for an advocacy/advisory package offered to industry associations, member companies and other Government agencies related to the Food Sector with the intention that this Industrial Sector will adopt the main principles of energy/water efficiency and reduction of environmental releases. The adoption of such principles and practices will assist industrial operations to reduce operation costs, thus become more competitive in the global marketplace. It will also serve some of the primary objectives of the MOEE which are to foster a growing economy, energy and water conservation and a cleaner environment in Ontario.

## II: BACKGROUND:

The Industry Programs Branch has traditionally been the lead Government agency in advocating, fostering and catalyzing energy efficiency and conservation amongst the industrial sectors in Ontario. In addition, jointly with the Green Industry Office of the MOEE, the Branch is spearheading the Green Industry Strategy.

Through a spectrum of programs and activities comprising expert advice, education and financial assistance, the Branch has acquired a sound market intelligence on energy, and to a lesser extent, water usage in the industrial base of the Province. Recently the Branch completed a pilot Green Analysis project which contributed information on potential to reduce environmental releases in some sectors.

Analysis of the Branch's existing information has led to the decision to assess the feasibility of focusing on some of the industrial sectors which are highly significant to the economy of the Province, show good promises of energy/water efficiency and environmental releases reduction, and are amenable to improvements by existing and up and coming technologies. For these reasons the Meat and Poultry Products Industries of the Food Sector has been selected as a suitable candidate for a sector-specific study. The choice of this sector is supported by the Ontario Ministry of Agriculture and Food.

## III. SCOPE:

The consultants will report to:

Soussan Tabari
Program Coordinator
Industry Programs
Ministry of Environment and Energy
56 Wellesley St. W
14th Floor
Toronto Ontario
M7A 2B7

Tel: (416) 327 1440
Fax: (416) 327 1261

They will work with the staff of the MOEE and, if applicable, other line ministries designated by her. The project is under the direction of Linda Ploeger, General Manager of the Industry Programs Branch.

The consultants will provide the MOEE with a final report in which they will discuss in depth the following topics:

**1. Sector Profile:**

a) a detailed, thorough description of the current profile of the Meat and Poultry Products Industries, including their economic status, their energy, water and resource usage, their cost of energy/water per unit of production, their infrastructure needs and usages, and their environmental pressure points.

b) a detailed projection of the sector's future environmental, energy, water and resources usage and related anticipated trends.

**2. Generic scope of work:**

a) a description of the main types of processes involved in Meat and Poultry Products plants.

b) a comprehensive description of all areas of process and equipment in each type of Meat and Poultry Products plants that should be examined in order to identify the optimum number of opportunities for conservation and efficient use of energy and water, and reduction at source of environmental releases.

It is emphasised that MOEE is primarily interested in a scope of work for areas that show potential for economically viable improvements (normally a simple payback period of up to 5 years). If there are areas of a plant that warrant evaluation but are not amenable to economic implementation, it is expected that the consultants will exercise judgment based on their own experience and will discuss these types of potentials separately.

**3. Key efficiency opportunities:** a brief description of commercially available equipment, technologies and management systems and practices that can be readily and economically accessed by any of the member companies of the Meat and Poultry Products Industries. The listing should comprise all means leading to savings and improvements that can be achieved immediately or in a short period of time (up to 5 years).

**4. New technologies:** a brief description of energy and water efficiency, and environmental releases reduction technologies that are being researched and developed and will be applicable to the Meat and Poultry Products Industries in the next 5 to 10 years.

**5. Applicability to other industries:** a brief discussion on the replicability of items 2, 3 and 4 to other industrial sectors.

# APPENDIX B

# APPENDIX B

# STUDY METHODOLOGY

The study methodology involved the following steps:

- Data Collection;
- Development of Sector Profiles;
- Description of Generic Processes;
- Identification of Key Efficiency Opportunities;
- Identification of New Technology; and
- Assessment of Applicability to Other Industries.

## B.1 Data Collection

Data was collected from a variety of sources for this study, including:

- Wardrop files;
- Sector profile information developed by Industry Canada and OMAF;
- Statistical data developed by OMAF and Statistics Canada;
- Industrial Energy Services Program aggregate data on energy and water use;
- Visits to representative establishments; and

- Industry association contacts and reports, such as trip reports prepared for the Canadian Meat Industry. Industry associations contacted included the Canadian Meat Council, Canadian Poultry Processors Association, and Ontario Independent Meat Packers and Processors Association.

## B.2 Development of Sector Profile

During this task, a detailed current profile of the meat and poultry industry in Ontario was developed, using information available in our files and the data gathered during the previous activity. This included relevant economic status, energy water and resource usage, and environmental effects.

## B.3 Description of Generic Processes

This activity involved two components:

- A description of main type of processes involved in Meat and Poultry products plants;
- A comprehensive description of all areas of processes involved in each type of Meat and Poultry Products plant that should be examined.

Based on the similarity of activities involved, four basic processes were considered:

- Beef processing;
- Poultry processing;
- Hog processing; and
- Rendering (both edible and inedible).

Utilities and service systems, such as refrigeration, boilers, water heaters and compressed air, were included in each plant type.

For clear and concise presentation, generic process flow diagrams were prepared, to be used as check lists of processes and plant areas. The processes presented in each diagram are referenced in the respective efficiency opportunities checklist.

## B.4 Identification of Key Efficiency Opportunities

For each generic process, a checklist of key efficiency opportunities was prepared. Each checklist incorporates a brief discussion of equipment, systems and management systems and practices that are commercially available to industry at this time. The focus was on technologies that have the potential to be economically viable at this time, based on the criterion of maximum 5 year payback.

Opportunities for utilities and services were also separately highlighted.

## B.5 Identification of New Technologies

New technologies that are currently being developed and could be available to the industry over the next five to ten years were identified. Technologies that are acceptable in other industries or other countries, and would likely be adapted to Ontario meat and poultry industries, were also included. Sources of information regarding new technologies included:

- R&D and technology commercialization programs of the Industry Programs Branch;
- Reports prepared under the Industrial Targeted Program of Energy Mines and Resources Canada;

- Recent publications such as Food Engineering, Foods in Canada, and other publications available through the Canadian Meat Council and Canadian Dairy Council libraries.

## B.6 Applicability to Other Industries

Comments on the potential application of generic technologies to other Ontario industries are provided.

# APPENDIX C

# APPENDIX C

# BACKGROUND ON MEAT AND POULTRY SECTOR

A brief description of meat and poultry processing in Ontario including its economic profile, environmental, energy and infrastructure aspects are presented in the following sections.

## C.1 Current Economic Profile

Meat and poultry processing is an important component of the food industry in Ontario. Economic figures for 1991, as summarized in Table C-1, show that this sector represents approximately:

- 23% of the value of all food industry shipments (for manufacturing activities);
- 22% of all food industry employment: and
- 21% of all food industry establishments in Ontario.

Because meat and poultry processing are highly regulated, the throughputs of animals being processed are well documented. Total throughput for Ontario in 1993 are provided in Table C-2.

All meat and poultry processing facilities must be inspected, either federally or provincially, and thus are all identified. Any facility exporting products outside of Ontario must be federally inspected, while facilities that supply products exclusively within Ontario can be Provincially inspected. The numbers of current federally and provincially inspected meat and poultry processing establishments are listed in Table C-3. These now total approximately 470.

## TABLE C-1

## ECONOMIC SUMMARY OF MEAT PROCESSING (RED MEAT AND POULTRY) IN ONTARIO FOR 1991

| GROUP NAME (AND SIC) | VALUE OF SHIPMENTS* ($) | EMPLOYEES (NUMBER) | ESTABLISHMENTS (NUMBER) |
|---|---|---|---|
| Red Meat<br>SIC 1011 | $2,466,200,000<br>16% of Total Food | 10,476<br>14% of Total Food | 159<br>17% of Total Food |
| Poultry<br>SIC 1012 | $1,027,500,000<br>7% of Total Food | 5,885<br>8% of Total Food | 40<br>4% of Total Food |
| Total Food | $15,172,800,000 | 73,453 | 948 |

Note: *Value of Shipments for Manufacturing Activities Only
Data from Statistics Canada for 1991

## TABLE C-2

## TOTAL MEAT AND POULTRY PROCESSING THROUGHPUT IN ONTARIO FOR 1993

| SPECIES | NUMBER SLAUGHTERED | LIVE WEIGHT | VALUE (FARM GATE) |
|---|---|---|---|
| Hogs | 4,304,600 | 439,825,000 kg | $ 561,916,600 |
| Cattle and Calves | 788,400 | 336,370,000 kg | 662,028,000 |
| Sheep and Lambs | 171,700 | 30,932,000 kg | 13,809,000 |
| Chickens (All wt groups) | 137,339,000 | 209,200,000 kg | 228,028,000 |
| Turkeys (All wt groups) | 7,953,000 | 55,969,000 kg | 77,271,000 |
| Stewing Hens (Fowl) | 18,605,061 | 24,903,000 kg | 8,748,000 |
| Ducks and Geese | 2,822,876 | 7,306,000 kg | 9,496,000 |

## TABLE C-3

## SUMMARY OF PROVINCIALLY AND FEDERALLY INSPECTED MEAT AND POULTRY PLANTS

| TYPE OF FACILITY | NUMBER OF PLANTS |
|---|---|
| Provincially Inspected Meat Plants (Licensed Ontario Meat Plants by Region, as of December 8, 1993, OMAF) | 294 |
| Federally Inspected Meat Plants (Registered Establishments, Alphabetical Listing, as of February 4, 1994, Agriculture Canada) | 180 |
| TOTAL | 474 |

## TABLE C-4

## SUMMARY OF ESTABLISHMENTS WITH MEAT AND POULTRY PROCESSING AS PRIMARY ACTIVITY (DATA FROM SCOTT'S DIRECTORY FOR 1992)

| US SIC CODE | DESCRIPTION | NUMBER OF FIRMS* | CAN SIC CODE | DESCRIPTION |
|---|---|---|---|---|
| 2011 | Meat Packing Plants | 125 | 1011 | Meat and Meat Products |
| 2013 | Sausages and Other Prepared Meats | 108 | 1011 | Meat and Meat Products |
| 2015 | Poultry Slaughtering and Processing | 42 | 1012<br>1099 | Poultry Products<br>Other Food Products |
| 2077 | Animal Fats and Oils | 4 | 1011<br>1021 | Meat and Meat Products<br>Fish Products |
| Meat and Poultry Total | | 238 | | |

## TABLE C-5

## CRITERIA FOR IDENTIFICATION OF LARGE PLANTS

| TYPE OF ANIMAL PROCESSED | SLAUGHTER (ANIMALS PER DAY) |
|---|---|
| Beef | 500+ |
| Hogs | 2,500+ |
| Chicken | 50,000+ |
| Turkeys | 6,000+ |

## TABLE C-6

## IDENTIFIED LARGE ONTARIO MEAT AND POULTRY PROCESSING PLANTS

| TYPE OF ANIMAL PROCESSED | IDENTIFIED LARGE PLANTS |
|---|---|
| Beef | Better Beef, Guelph<br>MGI, Guelph |
| Hogs | Fearman, Burlington<br>Quality Packers, Toronto<br>J.M. Schneider, Kitchener |
| Chicken | Maple Lodge Farms, Norval<br>The Poultry Company, Brampton<br>Prime Poultry, Toronto<br>Maple Leaf Foods, Dundas<br>Cuddy Foods, London |
| Turkeys | Cold Spring Farms, Thamesford<br>Parrish & Heimbecker, Hanover<br>Cuddy Foods, London |
| Rendering | Rothsay Recycling, Moorefield (Inedible)<br>Rothsay Orenco, Dundas (Inedible)<br>Hubberts, Brampton (Edible) |

Regulations cover any plants that may involve some handling of meat, even if meat or poultry processing is not a primary activity. Data is presented in Table C-4 from the 1992 Scott's Directory on the number of firms that have indicated meat or poultry processing as a primary activity. From this data, the number of establishments primarily involved in meat and poultry processing is approximately 240.

In terms of microeconomic market structure, meat and poultry processing in Ontario can in general be classified as oligopolistic in nature. An oligopoly, as opposed to a pure monopoly, indicates a market where relatively few processors account for a substantial proportion of output. In the overall processing of beef, hogs, chickens and turkeys, the output of the largest four processors in each case represents 60% to 80% or more of the respective provincial market, dependent on the animal species processed (based on data presented in Deloitte & Touche, 1992).

In order to quantify the difference between large and small plants, a series of criteria were developed, as presented in Table C-5. These criteria, presented in terms of slaughter figures per day, define large plants, with small plants being those that do not meet the definition. Although somewhat arbitrary in nature, these criteria allow a differentiation of large and small plants. A listing of relevant large meat and poultry processing plants is presented in Table C-6.

## C.2 Water Use

In reviewing water use information, and projecting consumption for the meat and poultry sector the following are important conclusions:

- Current water use data is limited, and is highly variable. Unfortunately, the collection and compilation of accurate water use data historically has not been a priority for industry in general, and this trend is reflected in the meat and poultry processing sector. This is due in part to the typical low cost associated with this resource in the past, and its frequent treatment as more of a fixed or overhead cost, rather than a variable manufacturing cost.

## TABLE C-7

## WATER CONSUMPTION IN VARIOUS MEAT PROCESSING OPERATIONS

| SPECIES TYPE | WATER CONSUMPTION |
|---|---|
| Beef<br>(Calves and Small Stock) | 800 to 1,700 L per Carcass |
| Hogs | 180 to 450 L per Hog Range<br>Reasonable target is<br>180 to 230 L per Hog |
| Poultry | 12 to 55 L per Bird for Chicken<br>Desired Target is<br>12 to 18 L per Bird Range<br>90 to 118 L per Bird for Turkey |
| Rendering | 5 to 20 L/kg Input throughput<br>(condenser and washup)<br>Recycle of water employed<br>Net water producer (condensate from product) |

## TABLE C-8
## EXTRAPOLATED WATER USE FOR ONTARIO (1993)

| SPECIES | NUMBER SLAUGHTERED | WATER CONSUMPTION (L/animal) | TOTAL WATER USE ($m^3$) |
|---|---|---|---|
| Hogs | 4,304,600 | 180 TO 450 | 775,000 to 1,937,000 |
| Cattle (and Small Stock) | 960,100 | 800 to 1,700 | 768,000 to 1,632,000 |
| Chickens, Hens, Geese and Ducks | 158,767,000 | 12 to 55 | 1,905,000 to 8,732,000 |
| Turkeys (All wt groups) | 7,953,000 | 90 to 118 | 716,000 to 938,000 |
| TOTAL | | | 4,164,000 to 13,239,000 |

- Caution should be exercised if extrapolating any water data presented in this report to individual plants, because of the presence of inherently inadequate or inaccurate data.

- More work needs to be done to collect and compile accurate water usage data.

Water consumption ranges for meat and poultry plants, categorized according to the four major types of processes, are summarized in Table C-7 (Table 2 in main text). The range of data presented is drawn from various sources, including literature and direct contacts. Actual consumption can vary substantially from plant to plant, being dependent on capacity, product mix, and other site specific factors.

Poultry processing tends to be the most water intensive process, based on water use per kilogram of input or final product. Beef and hog processing have lower water use requirements. Rendering requires a fairly significant water throughput, primarily for condenser cooling, however, water recycling is frequently undertaken, substantially reducing fresh water requirements. This process is also a net producer of water, as a result of the cooking and drying of input materials.

Based on the range of water consumption figures (Table C-7) and 1993 total slaughter figures for Ontario (Table C-2), an estimate of total water consumption for the meat and poultry industry in Ontario is presented in Table C-8. This extrapolation suggests a total water consumption for the industry in 1993 ranging from approximately 4 to 13 million $m^3$, excluding rendering activities.

Estimates of water consumption per plant are presented in Table C-9. These water consumption estimates include:

- Average red meat and poultry plants, based on total estimated industry water consumption (Table C-7) and the number of primary processing plants (Table C-4).

## TABLE C-9

## ESTIMATE OF AVERAGE PLANT WATER CONSUMPTION FOR MEAT AND POULTRY PLANTS

| PLANT TYPE | NUMBER OF PLANTS | TOTAL WATER CONSUMPTION ($m^3/y$) | AVERAGE PER PLANT ($m^3/y/plant$) |
|---|---|---|---|
| Average Red Meat (Hogs, Cattle, and Small Stock) | 125* | 1,543,000 to 3,569,000 | 12,300 to 28,600 |
| Large Beef (500+ per day) | | | 100,000 to 213,000+ |
| Large Hog (2,500+ per day) | | | 113,000 to 281,000+ |
| Average Poultry | 42* | 2,621,000 to 9,670,000 | 62,400 to 230,200 |
| Large Chicken (50,000+ per day) | | | 150,000 to 688,000+ |
| Large Turkey (6,000+ per day) | | | 135,000 to 177,000+ |
| IESP Data Water Bills for Various Industries | 42 Plants (2 in Meat and Poultry) | | 168,000 |

* Only number of primary processing plants considered, as indicated in Scotts Directory data for 1992.

- Large red meat and poultry plants, based on minimum slaughter figures (Table C-5) and consumption per animal (Table C-7).

- Comparative average plant water consumption, based on aggregate data collected through the Industrial Energy Services Program (IESP). This aggregate data was collected from 42 plants in various industries, including 2 from the meat and poultry sector. The data showed an average water consumption of 168,000 $m^3$ per year per plant, with 19 of 42 plants (45%) having a consumption exceeding 100,000 $m^3$ per year.

Based on these projections, water consumption for average meat and poultry plants is lower than that from the IESP data. Average red meat plant consumption is significantly lower, while average poultry plant consumption is somewhat lower. On the other hand, estimated water consumption for large meat and poultry plants, based on the minimum sizes defined, is comparable with the IESP average figures.

## C.3 Energy Use

Energy consumption ranges for meat and poultry plants, categorized according to the four major types of processes, are summarized in Table C-10 (Table 1 in main text). The range of data presented is drawn from various sources, including literature and direct contacts. Actual consumption can vary substantially from plant to plant, being dependent on capacity, product mix, and other site specific factors.

Additional data on energy consumption, derived from the Industrial Energy Services Program is presented in Appendix E.

## TABLE C-10

## ENERGY CONSUMPTION RANGE IN VARIOUS MEAT PROCESSING OPERATIONS

| SPECIES TYPE | ELECTRICITY | THERMAL ENERGY |
|---|---|---|
| Beef (Calves and Small Stock) | .07 to .25 kWh/kg DW | 200 to 500 kJ/kg DW |
| Hogs | .07 to .30 kWh/kg HDW | 500 to 900 kJ/kg HDW |
| Poultry | .13 to .25 kWh/bird | 1,200 to 2,000 kJ/bird |
| Rendering | 0.05 to 0.15 kWh/kg input | 1,800 to 7,000 kJ/kg input (for average raw material with 58% moisture) |

## C.4 Environmental Issues

Available literature, and contacts with industry indicate a variety of recognized environmental pressure points in the meat and poultry industry.

The Canadian Meat Council, in a recent study on energy efficiency and environmental impact, indicated a number of environmental priorities and pressure points. These are listed in Table C-11, although in no specific order of precedence.

A recent SWOT analysis of the meat and poultry sector for OMAF by Deloitte and Touche identified the following important environmental issues:

- Environmental regulations requiring processors to reduce wastes is an important industry issue in beef, pork, chicken and turkey processing.
- Wastewater disposal is becoming a problem in beef and pork processing.
- Blood and feather disposal is becoming a major problem in poultry processing, given the low cost of alternatives feeds, and the corresponding low demand for blood and feathers as feed ingredients.

A recent paper by staff at Georgia Tech Research Institute, regarding an overview of environmental concerns in the U.S. meat and poultry process industry, indicated the following four principle environmental issues:

- Ammonia control.
- Government regulations.
- Sludge management.
- Lack of pretreatment facilities, due largely to fluctuations in wastewater character and changes in environmental regulations.

## TABLE C-11

## CANADIAN MEAT INDUSTRY'S PRIORITIES AND PRESSURE POINTS

| ENVIRONMENTAL | CONSERVATION |
|---|---|
| Disposal of waxed corrugated cartons | Hang scald, carcass wash |
| Disposal of wiener casings and other organic casings | Heat reclamation from singeing, sewage, boilers, smokehouses and cookhouses |
| Mixed plastic wastes | Refrigeration systems |
| MISA auditing and waste characterization | Frozen storage |
| Burned saw dust | Building construction |
| Sewage skimmings/sludge/grit | Truck scaling technologies on loading docks |
| Beef, hog and poultry manure | Rendering operations, drying of final products |
| Paunch manure | |
| Nettings | |
| Sewer surcharges | |

Canadian Meat Council, 1993.

Additional environmental issues identified through the course of this study include:

- CFC replacement in refrigeration systems.
- Byproduct disposal for small processors.
- Wastewater treatment sludge disposal.

# APPENDIX D

# APPENDIX D

# RELEVANT STATUES AND REGULATIONS FOR MEAT AND POULTRY PROCESSING

## TABLE D-1

## RELEVANT STATUES GOVERNING MEAT AND POULTRY PROCESSING OPERATIONS IN ONTARIO

| RESPONSIBLE REGULATORY DEPARTMENT | RELEVANT FEDERAL LEGISLATION | RELEVANT PROVINCIAL LEGISLATION | PURPOSE OF REGULATION |
|---|---|---|---|
| Agriculture Canada | *Meat Inspection Act*<br>*Agricultural Products Standards Act* | | Ensure slaughter, inspection, grading and product quality standards are maintained.<br>Food safety!!! |
| Consumer and Corporate Affairs Canada | *Food and Drug Act*<br>*Consumer Packaging and Labelling Act* | | Ensure proper labelling of food ingredients. |
| Health Canada | *Food and Drug Act* | | Ensure product safety, consumer health, and freedom from adulteration. |
| Ontario Ministry of Agriculture and Food | | *Meat Inspection Act (Ontario)* | |

Abstracts from Federal "Meat Inspection Regulations" regarding Water Reuse attached.

**Water reuse**

In the interest of conservation of water and energy, water reuse proposals, by operators of registered establishments, are being given consideration by the Meat and Poultry Products Division. On receipt of details and data, submitted via the inspector-in-charge and the Regional Director, Foods Inspection the acceptability of the proposal is evaluated. In essence, the reuse of water shall not create any unsanitary state in elation to the product or the plant environment. Used water should only be reused in a more contaminated step of the dressing process.

As an example, the reuse of water from the overflow of chill tanks, all automatic equipment rinses, carcass washes (pre/post rehang, inside/outside carcass washer) and screened viscera trough water may be permitted to supplement the water used in the feather flume and the viscera trough.

Another example is the reuse of water from the hog dehairing machine in the first two thirds of the same machine, provided the last third is supplied exclusively with potable water.

Consideration may also be given to reuse of water in cleaning procedures as a preliminary rinse in live receiving and defeathering areas or in the initial section of the crate washer In these instances a thorough clean-up with appropriate acceptable cleaning and sanitizing agents in potable water followed by a potable water rinse will be required.

The pipes and pumps used to transport this water to the point of reuse must be constructed from materials and in a manner facilitating thorough cleaning and inspection of inside and outside surfaces. The cleaning process must remove all accumulation of organic matter from the inside and outside surfaces to avoid creation of an environment that could lead to bad odours and facilitate bacterial multiplication. Lines for reused water may only be used for this purpose and must be clearly identified to distinguish them from potable water lines.

Submissions for water reuse acceptance must include:

- a diagram or a sketch indicating the whole cycle of water reuse. Location of pipes and pumps must be indicated as well as their relationship to nearby equipment and operations. Sanitary conditions in any area must not be compromised by the proposed system.

- detailed cleaning procedure, including frequency, for the system accompanied by an inspection procedure to be carried out by the company to verify it's effectiveness.

A system may be approved for the treatment of water utilized in the chilling of poultry. When permission is granted and before any modifications are made to the chilling unit, the operator has to establish the bacterial load of its system, on an hourly basis for a 30 day period, using the parameters mentioned in the following section a).

Initially , an application may be made by an operator to operate the system for a 90 day trial period in the plant at full scale production rates.

It is understood that this could only take place once the equipment and the proposed process (including type of filters, frequency of filter changes, back-flushing or other system restoration, rate of flow, pressure and/or vacuums required for suitable operations, point of exit from the chilling unit of water to be reconditioned, point of entry into the chilling unit of the reconditioned water, and any other conditions the alteration of which could affect the effectiveness of the reconditioning) have been approved by the Chief, plants and Equipment, based on:

a) data provided by the equipment manufacturer which demonstrate the ability of the proposed system to meet the following criteria for the treated water:

  - total plate count of less than 1000 organisms/ml

  - total coliform count less than 10 organisms/ml

  - total E. coli count less than 2 organisms/ml

  - total organic carbon less than 100 mg/L and

  - percent light transmission of greater than 90%T.

b) the microbiological, physical and chemical standards (bacterial load reduction, % of light transmission of treated water and residual organic carbon, residual ozone in the water in contact with the carcasses and in the air over the chill unit) that are anticipated for the proposed system.

During the 90 day trial period, microbial, physical and chemical testing will have to be carried out by the operator. The purpose of this trial period is to:

.../10

i) demonstrate that the criteria mentioned above in a) are met;

ii) determine the concentration of residual ozone that may come into direct contact with the poultry;

iii) establish the maximum use level of ozone in the system before a residual level of 0.05 ppm is reached in the atmosphere;

iv) confirm the concentration of ozone generated, during normal operational conditions, in the air over the chiller in order to ensure that it is less than 0.05 ppm as per Health and Welfare Canada requirements.

Health and Welfare Canada standard laboratory procedures will have to be used. This evaluation will enable the operator and the inspection staff to eventually evaluate the true efficiency of the reconditioning process.

Sampling will be done as per the following schedule:

- from chiller at point of entry to the recirculating unit:

  beginning of the kill
  08:30
  10:30
  13:30
  end of the kill

- after treatment before going back into the chiller:

  half hour later
  09:00
  11:00
  14:00
  half hour later

Once the efficacy of the water recirculation is proven, the Regional Director (Meat Hygiene Program) will approve a reduction in fresh water intake requirements at the rate of one litre of fresh water for each litre of reconditioned water.

Upon approval, microbial (a) above and chemical (residual ozone in contact with the product and over the chill unit) testing will be required from the operator twice a week at times randomly selected by the veterinarian in charge. There must be an on-line monitor for the percentage of light transmission (%T) that sets off a visible or audible alarm and interrupts the flow of recirculated water when the %T is less than 90.

# APPENDIX E

## APPENDIX E

## IESP INFORMATION ON MEAT AND POULTRY PRODUCTS INDUSTRIES

To date the Ministry of Environment and Energy has completed 16 energy audits in the Meat and Poultry products sector (13 in Meat and 3 in Poultry, respectively).

**Annual consumption cost of energy**: the total annual energy consumption cost for the 16 plants is $14.2 million (see Table 1), averaging $887,000. The largest plant consumes close to $4.4 million of energy per year.

**Potential annual cost savings:** for the above mentioned annual consumption, the energy analyses have identified $1.15 million in potential savings per year (Table 1) . This translates into an average potential savings of 8% of the annual consumption cost. However, in several plants the savings range between 12 and 20%. In one case the potential savings are as high as 42%.

**Potential annual energy savings:** the 16 Meat & Poultry plants consume in excess of 2.3 petajoules of electricity and natural gas. The savings are equivalent to 0.23 petajoules or 10.3% of the annual consumption.

**Energy Efficiency Opportunities (EEO):** the energy audits identified 92 EEO in these 16 plants. Table 2 shows the description of these EEO along with the capital expenditure needed to implement them, the savings that can occur as a result of their implementation and the simple payback period for each item. In total, in order to realize the $1.15

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## TABLE 2: EEO IN MEAT & POULTRY

| EEO DESCRIPTION | CAPITAL EXPENDITURE | POTENTIAL ANNUAL SAVINGS | PAYBACK PERIOD |
|---|---|---|---|
| Power Factor Improvement | $5,000 | $2,500 | 2.00 |
| | $3,750 | $2,800 | 1.34 |
| | $33,150 | $30,597 | 1.08 |
| | $7,234 | $3,617 | 2.00 |
| | $2,572 | $3,364 | 0.80 |
| Total: | $51,706 | $42,878 | |
| Install demand controller/load shedder | $10,000 | $5,263 | 1.90 |
| | $8,000 | $4,200 | 1.90 |
| | $10,000 | $5,465 | 1.83 |
| | $9,500 | $6,653 | 1.43 |
| | $12,000 | $4,300 | 2.79 |
| Total: | $49,500 | $25,881 | |
| Rescheduling to avoid peaks | $0 | $10,000 | 0.00 |
| | $10,000 | $2,800 | 3.57 |
| | $4,300 | $1,944 | 2.20 |
| Total: | $14,300 | $14,744 | |
| Install high intensity discharge (HID) lighting | $20,520 | $8,117 | 2.50 |
| | $35,200 | $7,600 | 4.63 |
| Total: | $55,720 | $15,717 | |
| Install low wattage fluorescent tubes | $926 | $490 | 1.89 |
| Total: | $926 | $490 | |
| Install lighting controls | $400 | $2,462 | 0.20 |
| | $5,000 | $35,000 | 0.14 |
| Total: | $5,400 | $37,462 | |
| Optimize motor size load | $20,000 | $5,000 | 4.00 |
| | $1,000 | $2,814 | 0.36 |
| Total: | $21,000 | $7,814 | |
| Use multiple-speed motors or variable-speed drives | $75,000 | $22,500 | 3.30 |
| Total: | $75,000 | $22,500 | |
| Compressed air | $6,000 | $7,006 | 0.90 |
| Total: | $6,000 | $7,006 | |
| Upgrade insulation | $6,000 | $3,300 | 1.82 |
| | $2,800 | $1,400 | 2.00 |
| | $300 | $500 | 0.60 |
| Total: | $9,100 | $5,200 | |

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## TABLE 2: EEO IN MEAT & POULTRY

| EEO DESCRIPTION | CAPITAL EXPENDITURE | POTENTIAL ANNUAL SAVINGS | PAYBACK PERIOD |
|---|---|---|---|
| Heat exchange techniques to precondition incoming air with exhaust air | $30,000 | $10,000 | 3.00 |
| Total: | $30,000 | $10,000 | |
| Recover waste heat from air conditioning or refrigeration | $20,000 | $5,570 | 3.60 |
| Total: | $20,000 | $5,570 | |
| Install timed equipment to control HVAC | $18,000 | $4,000 | 4.50 |
| | $5,600 | $5,584 | 1.00 |
| Total: | $23,600 | $9,584 | |
| Replace existing heating system with a radiant heating system | $51,000 | $18,500 | 2.76 |
| Total: | $51,000 | $18,500 | |
| Set correct fuel/air ratio | $3,580 | $11,300 | 0.32 |
| | $2,600 | $2,100 | 1.24 |
| Total: | $6,180 | $13,400 | |
| Process heat for boiler feedwater or combustion air | $3,000 | $1,500 | 2.00 |
| Total: | $3,000 | $1,500 | |
| Miscellaneous boiler efficiency improvements | $5,000 | $11,300 | 0.44 |
| | $2,500 | $4,468 | 0.60 |
| Total: | $7,500 | $15,768 | |
| Optimize boiler operation/loading | $19,000 | $11,300 | 1.68 |
| Total: | $19,000 | $11,300 | |
| Install Oxygen trim control | $13,200 | $9,000 | 1.47 |
| | $12,000 | $5,000 | 2.40 |
| Total: | $25,200 | $14,000 | |
| Install automatic blowdown control | $4,000 | $1,852 | 2.16 |
| Total: | $4,000 | $1,852 | |
| Boiler maintenance | $0 | $49,277 | 0.00 |
| | $2,000 | $3,532 | 0.60 |
| Total: | $2,000 | $52,809 | |
| Replace and upgrade equipment (new boiler, control systems) | $1,800 | $1,200 | 1.50 |
| | $3,500 | $4,610 | 0.76 |
| | $54,000 | $26,283 | 2.05 |
| Total: | $59,300 | $32,093 | |

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TABLE 2: EEO IN MEAT & POULTRY

| EEO DESCRIPTION | CAPITAL EXPENDITURE | POTENTIAL ANNUAL SAVINGS | PAYBACK PERIOD |
|---|---|---|---|
| Heat recovery from flue gases for boiler operations | $100,000 | $35,618 | 2.81 |
| | $100,000 | $41,861 | 2.39 |
| | $54,000 | $11,500 | 4.70 |
| | $21,000 | $6,340 | 3.31 |
| | $5,000 | $3,143 | 1.59 |
| | $7,000 | $4,347 | 1.61 |
| | $4,200 | $2,146 | 1.96 |
| | $175,000 | $69,743 | 2.51 |
| | $35,800 | $10,600 | 3.38 |
| Total: | $502,000 | $185,298 | |
| Heat recovery from flue gases for process heat | $2,500 | $3,577 | 0.70 |
| | $47,000 | $20,000 | 2.35 |
| Total: | $49,500 | $23,577 | |
| Boiler blowdown heat recovery | $3,000 | $1,600 | 1.88 |
| Total: | $3,000 | $1,600 | |
| Upgrade and insulate steam lines and distribution systems | $3,300 | $2,609 | 1.30 |
| | $31,000 | $15,962 | 1.90 |
| Total: | $34,300 | $18,571 | |
| Repair steam system leaks | $0 | $936 | 0.00 |
| Total: | $0 | $936 | |
| Miscellaneous steam system improvements | $10,000 | $7,535 | 1.33 |
| Total: | $10,000 | $7,535 | |
| Equipment shutdown | $500 | $500 | 1.00 |
| Total: | $500 | $500 | |
| Install equipment controls | $20,000 | $32,681 | 0.61 |
| | $7,500 | $17,000 | 0.44 |
| Total: | $27,500 | $49,681 | |
| Equipment replacement | $15,000 | $5,860 | 2.56 |
| Total: | $15,000 | $5,860 | |
| Process design | $10,000 | $25,400 | 0.39 |
| Total: | $10,000 | $25,400 | |
| Operation modifications | $0 | $14,500 | 0.00 |
| Total: | $0 | $14,500 | |

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## TABLE 2: EEO IN MEAT & POULTRY

| EEO DESCRIPTION | CAPITAL EXPENDITURE | POTENTIAL ANNUAL SAVINGS | PAYBACK PERIOD |
|---|---|---|---|
| Heat recovery from exhaust or effluent streams for process use | $11,700 | $2,800 | 4.18 |
| | $25,000 | $9,500 | 2.63 |
| | $15,000 | $3,200 | 4.70 |
| | $27,000 | $47,400 | 0.57 |
| | $42,000 | $37,500 | 1.12 |
| | $100,000 | $88,500 | 1.13 |
| | $8,890 | $8,650 | 1.03 |
| Total: | $229,590 | $197,550 | |
| Recovery of heat from equipment for process use (air compressor) | $1,000 | $2,200 | 0.45 |
| | $126,105 | $37,803 | 3.30 |
| | $2,000 | $1,800 | 1.10 |
| Total: | $129,105 | $41,803 | |
| Heat recovery for space heating from process effluent/equipment/exhaust | $15,220 | $6,017 | 2.53 |
| | $28,000 | $9,300 | 3.01 |
| Total: | $43,220 | $15,317 | |
| Equipment insulation (tanks, hoods, presses) | $7,300 | $2,280 | 3.20 |
| Total: | $7,300 | $2,280 | |
| General refrigeration improvements | $22,800 | $6,150 | 3.71 |
| | $43,000 | $42,916 | 1.00 |
| | $10,000 | $13,600 | 0.74 |
| | $0 | $3,418 | 0.00 |
| | $40,000 | $17,700 | 2.26 |
| | $0 | $1,600 | 0.00 |
| | $0 | $5,700 | 0.00 |
| | $73,000 | $43,584 | 1.70 |
| Total: | $188,800 | $134,668 | |
| Water | $0 | $7,511 | 0.00 |
| | $0 | $830 | 0.00 |
| Total: | $0 | $8,341 | |
| Miscellaneous energy | $95,000 | $40,000 | 2.38 |
| | $14,000 | $7,680 | 1.82 |
| | $1,920 | $7,128 | 0.27 |
| Total: | $110,920 | $54,808 | |
| Total: | $1,900,167 | $1,154,293 | |

million savings a capital investment of $1.9 million is necessary, which means a simple payback period of 1.6 years.

Table 3 is a listing of those EEO that are process-related (also on pages 3 & 4 of Table 2). Data in this Table suggest that the main areas of process-related potential energy savings are in Refrigeration Improvement and Heat Recovery from various stages of the Process. The process-related EEO represent 38% of the total potential savings.

**EEO by Fuel Type**: in Table 4 the EEO identified in the course of the 16 audits have been broken down by fuel type. From these data, it is clear that the majority of the opportunities lie in conservation of natural gas. Of the total potential savings, about $415,000 or 36% is in electricity and about $730,000 or 63% is in natural gas.

With respect to capital spending needed to implement these EEO the percentages are slightly more polarized. To realize the $1.15 million savings a capital spending of about $565,000 in electricity applications and $1.33 million in natural gas applications are needed. These figure represent 30% and 70% of the total capital expenditure, respectively. Thus the simple payback period for electricity is better (1.4 years) than that of natural gas (1.8 years).

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TABLE 3: PROCESS-RELATED EEO IN MEAT & POULTRY SECTOR

| | EEO DESCRIPTION | CAPITAL EXPENDITURE | POTENTIAL ANNUAL SAVINGS |
|---|---|---|---|
| | Equipment insulation (tanks, hoods, presses) | $7,300 | $2,280 |
| | Total: | $7,300 | $2,280 |
| | Equipment replacement | $15,000 | $5,860 |
| | Total: | $15,000 | $5,860 |
| | General refrigeration improvements | $0 | $1,600 |
| | | $43,000 | $42,916 |
| | | $10,000 | $13,600 |
| | | $0 | $3,418 |
| | | $73,000 | $43,584 |
| | | $22,800 | $6,150 |
| | | $0 | $5,700 |
| | | $40,000 | $17,700 |
| | Total: | $188,800 | $134,668 |
| | Heat recovery for space heating from process effluent/equipment/exhaust | $15,220 | $6,017 |
| | | $28,000 | $9,300 |
| | Total: | $43,220 | $15,317 |
| | Heat recovery from exhaust or effluent streams for process use | $42,000 | $37,500 |
| | | $15,000 | $3,200 |
| | | $25,000 | $9,500 |
| | | $100,000 | $88,500 |
| | | $8,890 | $8,650 |
| | | $11,700 | $2,800 |
| | | $27,000 | $47,400 |
| | Total: | $229,590 | $197,550 |
| | Operation modifications | $0 | $14,500 |
| | Total: | $0 | $14,500 |
| | Process design | $10,000 | $25,400 |
| | Total: | $10,000 | $25,400 |
| | Recovery of heat from equipment for process use (air compressor) | $1,000 | $2,200 |
| | | $2,000 | $1,800 |
| | | $126,105 | $37,803 |
| | Total: | $129,105 | $41,803 |
| Total: | | $623,015 | $437,378 |
| Count: | 24 | | |

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TABLE 4: EEO IN MEAT & POULTRY BY FUEL TYPE

| FUEL TYPE | EEO DESCRIPTION | CAPITAL EXPENDITURE | POTENTIAL ANNUAL SAVINGS |
|---|---|---|---|
| 1 | Compressed air | $6,000 | $7,006 |
| | Total: | $6,000 | $7,006 |
| | Equipment replacement | $15,000 | $5,860 |
| | Total: | $15,000 | $5,860 |
| | Equipment shutdown | $500 | $500 |
| | Total: | $500 | $500 |
| | General refrigeration improvements | $0 | $3,418 |
| | | $73,000 | $43,584 |
| | | $40,000 | $17,700 |
| | | $10,000 | $13,600 |
| | | $0 | $1,600 |
| | | $0 | $5,700 |
| | | $43,000 | $42,916 |
| | | $22,800 | $6,150 |
| | Total: | $188,800 | $134,668 |
| | Heat recovery for space heating from process effluent/equipment/exhaust | $28,000 | $9,300 |
| | Total: | $28,000 | $9,300 |
| | Install demand controller/load shedder | $8,000 | $4,200 |
| | | $10,000 | $5,465 |
| | | $12,000 | $4,300 |
| | | $10,000 | $5,263 |
| | | $9,500 | $6,653 |
| | Total: | $49,500 | $25,881 |
| | Install equipment controls | $20,000 | $32,681 |
| | | $7,500 | $17,000 |
| | Total: | $27,500 | $49,681 |
| | Install high intensity discharge (HID) lighting | $20,520 | $8,117 |
| | | $35,200 | $7,600 |
| | Total: | $55,720 | $15,717 |
| | Install lighting controls | $5,000 | $35,000 |
| | | $400 | $2,462 |
| | Total: | $5,400 | $37,462 |
| | Install low wattage fluorescent tubes | $926 | $490 |
| | Total: | $926 | $490 |
| | Miscellaneous energy | $14,000 | $7,680 |
| | | $1,920 | $7,128 |

1: ELECTRICITY
2: NATURAL GAS
3: COAL

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## TABLE 4: EEO IN MEAT & POULTRY BY FUEL TYPE

| FUEL TYPE | EEO DESCRIPTION | CAPITAL EXPENDITURE | POTENTIAL ANNUAL SAVINGS |
|---|---|---|---|
| | Total: | $15,920 | $14,808 |
| | Optimize motor size load | $1,000 | $2,814 |
| | | $20,000 | $5,000 |
| | Total: | $21,000 | $7,814 |
| | Power Factor Improvement | $3,750 | $2,800 |
| | | $2,572 | $3,364 |
| | | $5,000 | $2,500 |
| | | $33,150 | $30,597 |
| | | $7,234 | $3,617 |
| | Total: | $51,706 | $42,878 |
| | Process design | $10,000 | $25,400 |
| | Total: | $10,000 | $25,400 |
| | Rescheduling to avoid peaks | $0 | $10,000 |
| | | $10,000 | $2,800 |
| | | $4,300 | $1,944 |
| | Total: | $14,300 | $14,744 |
| | Use multiple-speed motors or variable-speed drives | $75,000 | $22,500 |
| | Total: | $75,000 | $22,500 |
| | Water | $0 | $830 |
| | Total: | $0 | $830 |
| Tot: | | $565,272 | $415,539 |
| Cnt: | 39 | | |
| 2 | Boiler blowdown heat recovery | $3,000 | $1,600 |
| | Total: | $3,000 | $1,600 |
| | Boiler maintenance | $2,000 | $3,532 |
| | | $0 | $49,277 |
| | Total: | $2,000 | $52,809 |
| | Equipment insulation (tanks, hoods, presses) | $7,300 | $2,280 |
| | Total: | $7,300 | $2,280 |
| | Heat exchange techniques to precondition incoming air with exhaust air | $30,000 | $10,000 |
| | Total: | $30,000 | $10,000 |

1: ELECTRICITY
2: NATURAL GAS
3: COAL

Feb 9, 1994

TABLE 4: EEO IN MEAT & POULTRY BY FUEL TYPE

| FUEL TYPE | EEO DESCRIPTION | CAPITAL EXPENDITURE | POTENTIAL ANNUAL SAVINGS |
|---|---|---|---|
| 2 | Heat recovery for space heating from process effluent/equipment/exhaust | $15,220 | $6,017 |
| | Total: | $15,220 | $6,017 |
| | Heat recovery from exhaust or effluent streams for process use | $42,000 | $37,500 |
| | | $100,000 | $88,500 |
| | | $8,890 | $8,650 |
| | | $11,700 | $2,800 |
| | | $25,000 | $9,500 |
| | | $27,000 | $47,400 |
| | | $15,000 | $3,200 |
| | Total: | $229,590 | $197,550 |
| | Heat recovery from flue gases for boiler operations | $54,000 | $11,500 |
| | | $175,000 | $69,743 |
| | | $35,800 | $10,600 |
| | | $4,200 | $2,146 |
| | | $7,000 | $4,347 |
| | | $100,000 | $35,618 |
| | | $100,000 | $41,861 |
| | | $5,000 | $3,143 |
| | | $21,000 | $6,340 |
| | Total: | $502,000 | $185,298 |
| | Heat recovery from flue gases for process heat | $47,000 | $20,000 |
| | Total: | $47,000 | $20,000 |
| | Install automatic blowdown control | $4,000 | $1,852 |
| | Total: | $4,000 | $1,852 |
| | Install Oxygen trim control | $13,200 | $9,000 |
| | | $12,000 | $5,000 |
| | Total: | $25,200 | $14,000 |
| | Install timed equipment to control HVAC | $5,600 | $5,584 |
| | | $18,000 | $4,000 |
| | Total: | $23,600 | $9,584 |
| | Miscellaneous boiler efficiency improvements | $2,500 | $4,468 |
| | | $5,000 | $11,300 |
| | Total: | $7,500 | $15,768 |
| | Miscellaneous energy | $95,000 | $40,000 |
| | Total: | $95,000 | $40,000 |
| | Miscellaneous steam system improvements | $10,000 | $7,535 |
| | Total: | $10,000 | $7,535 |

1: ELECTRICITY
2: NATURAL GAS

Feb 9, 1994

TABLE 4: EEO IN MEAT & POULTRY BY FUEL TYPE

| FUEL TYPE | EEO DESCRIPTION | CAPITAL EXPENDITURE | POTENTIAL ANNUAL SAVINGS |
|---|---|---|---|
| 2 | Operation modifications | $0 | $14,500 |
| | Total: | $0 | $14,500 |
| | Optimize boiler operation/loading | $19,000 | $11,300 |
| | Total: | $19,000 | $11,300 |
| | Process heat for boiler feedwater or combustion air | $3,000 | $1,500 |
| | Total: | $3,000 | $1,500 |
| | Recover waste heat from air conditioning or refrigeration | $20,000 | $5,570 |
| | Total: | $20,000 | $5,570 |
| | Recovery of heat from equipment for process use (air compressor) | $126,105<br>$2,000<br>$1,000 | $37,803<br>$1,800<br>$2,200 |
| | Total: | $129,105 | $41,803 |
| | Repair steam system leaks | $0 | $936 |
| | Total: | $0 | $936 |
| | Replace and upgrade equipment (new boiler, control systems) | $1,800<br>$54,000 | $1,200<br>$26,283 |
| | Total: | $55,800 | $27,483 |
| | Replace existing heating system with a radiant heating system | $51,000 | $18,500 |
| | Total: | $51,000 | $18,500 |
| | Set correct fuel/air ratio | $2,600<br>$3,580 | $2,100<br>$11,300 |
| | Total: | $6,180 | $13,400 |
| | Upgrade and insulate steam lines and distribution systems | $31,000<br>$3,300 | $15,962<br>$2,609 |
| | Total: | $34,300 | $18,571 |
| | Upgrade insulation | $300<br>$2,800<br>$6,000 | $500<br>$1,400<br>$3,300 |
| | Total: | $9,100 | $5,200 |
| | Water | $0 | $7,511 |
| | Total: | $0 | $7,511 |

1: ELECTRICITY
2: NATURAL GAS
3: COAL

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## TABLE 4: EEO IN MEAT & POULTRY BY FUEL TYPE

| FUEL TYPE | EEO DESCRIPTION | CAPITAL EXPENDITURE | POTENTIAL ANNUAL SAVINGS |
|---|---|---|---|
| Tot: | | $1,328,895 | $730,567 |
| Cnt: | 51 | | |
| 3 | Heat recovery from flue gases for process heat | $2,500 | $3,577 |
| | Total: | $2,500 | $3,577 |
| | Replace and upgrade equipment (new boiler, control systems) | $3,500 | $4,610 |
| | Total: | $3,500 | $4,610 |
| Tot: | | $6,000 | $8,187 |
| Cnt: | 2 | | |
| Total: | | $1,900,167 | $1,154,293 |
| Count: | 92 | | |

1: ELECTRICITY
2: NATURAL GAS
3: COAL

**Implementation of EEO**: one to two years after the completion of the audits follow up visits are conducted to gather information on actions taken on the audits recommendations. For the 16 plants and 92 EEO, implementation action for 9 plants and 53 EEO is available. Of these 53 EEO, 30 EEO (or 57%) have been implemented of are planned to be implemented in the near future (Figure 1). In terms of annual savings they represent 47% of the potential savings (Figure 2) and in terms of capital expenditure they reflect 39% of the investment needed, for the 53 EEO.

**Water efficiency opportunities:** in one of the plants water savings of about $73,000 per year was identified. To implement these savings a capital investment of $4,700 is needed;i.e.: a payback period of less than 1 month.

Prepared by Soussan Tabari
February 8, 1994

Feb 9, 1994

TABLE 5: IMPLEMENTED/PLANNED TO BE IMPLEMENTED EEO IN MEAT & POULTRY SECTOR

| EEO DESCRIPTION | CAPITAL EXPENDITURE | POTENTIAL ANNUAL SAVINGS | PAYBACK PERIOD |
|---|---|---|---|
| Power Factor Improvement | $33,150 | $30,597 | 1.08 |
| Total: | $33,150 | $30,597 | |
| Install demand controller/load shedder | $9,500 | $6,653 | 1.43 |
| Total: | $9,500 | $6,653 | |
| Rescheduling to avoid peaks | $0 | $10,000 | 0.00 |
| Total: | $0 | $10,000 | |
| Install low wattage fluorescent tubes | $926 | $490 | 1.89 |
| Total: | $926 | $490 | |
| Install lighting controls | $5,000 | $35,000 | 0.14 |
| Total: | $5,000 | $35,000 | |
| Upgrade insulation | $6,000<br>$300 | $3,300<br>$500 | 1.82<br>0.60 |
| Total: | $6,300 | $3,800 | |
| Heat exchange techniques to precondition incoming air with exhaust air | $30,000 | $10,000 | 3.00 |
| Total: | $30,000 | $10,000 | |
| Replace existing heating system with a radiant heating system | $51,000 | $18,500 | 2.76 |
| Total: | $51,000 | $18,500 | |
| Set correct fuel/air ratio | $3,580 | $11,300 | 0.32 |
| Total: | $3,580 | $11,300 | |
| Miscellaneous boiler efficiency improvements | $5,000 | $11,300 | 0.44 |
| Total: | $5,000 | $11,300 | |
| Optimize boiler operation/loading | $19,000 | $11,300 | 1.68 |
| Total: | $19,000 | $11,300 | |
| Install Oxygen trim control | $12,000 | $5,000 | 2.40 |
| Total: | $12,000 | $5,000 | |
| Boiler maintenance | $0 | $49,277 | 0.00 |
| Total: | $0 | $49,277 | |
| Replace and upgrade equipment (new boiler, control systems) | $54,000 | $26,283 | 2.05 |
| Total: | $54,000 | $26,283 | |

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## TABLE 5: IMPLEMENTED/PLANNED TO BE IMPLEMENTED EEO IN MEAT & POULTRY SECTOR

| EEO DESCRIPTION | CAPITAL EXPENDITURE | POTENTIAL ANNUAL SAVINGS | PAYBACK PERIOD |
|---|---|---|---|
| Heat recovery from flue gases for boiler operations | $7,000 | $4,347 | 1.61 |
| | $100,000 | $41,861 | 2.39 |
| | $4,200 | $2,146 | 1.96 |
| | $5,000 | $3,143 | 1.59 |
| | $35,800 | $10,600 | 3.38 |
| | $54,000 | $11,500 | 4.70 |
| Total: | $206,000 | $73,597 | |
| Repair steam system leaks | $0 | $936 | 0.00 |
| Total: | $0 | $936 | |
| Miscellaneous steam system improvements | $10,000 | $7,535 | 1.33 |
| Total: | $10,000 | $7,535 | |
| Install equipment controls | $7,500 | $17,000 | 0.44 |
| Total: | $7,500 | $17,000 | |
| Operation modifications | $0 | $14,500 | 0.00 |
| Total: | $0 | $14,500 | |
| Recovery of heat from equipment for process use (air compressor) | $1,000 | $2,200 | 0.45 |
| Total: | $1,000 | $2,200 | |
| General refrigeration improvements | $40,000 | $17,700 | 2.26 |
| | $0 | $5,700 | 0.00 |
| | $0 | $1,600 | 0.00 |
| | $10,000 | $13,600 | 0.74 |
| Total: | $50,000 | $38,600 | |
| Total: | $503,956 | $383,868 | |

## ACTIONS TAKEN ON AUDIT RECOMMENDATIONS IN MEAT & POULTRY SECTOR

*Based on 63 EEO*

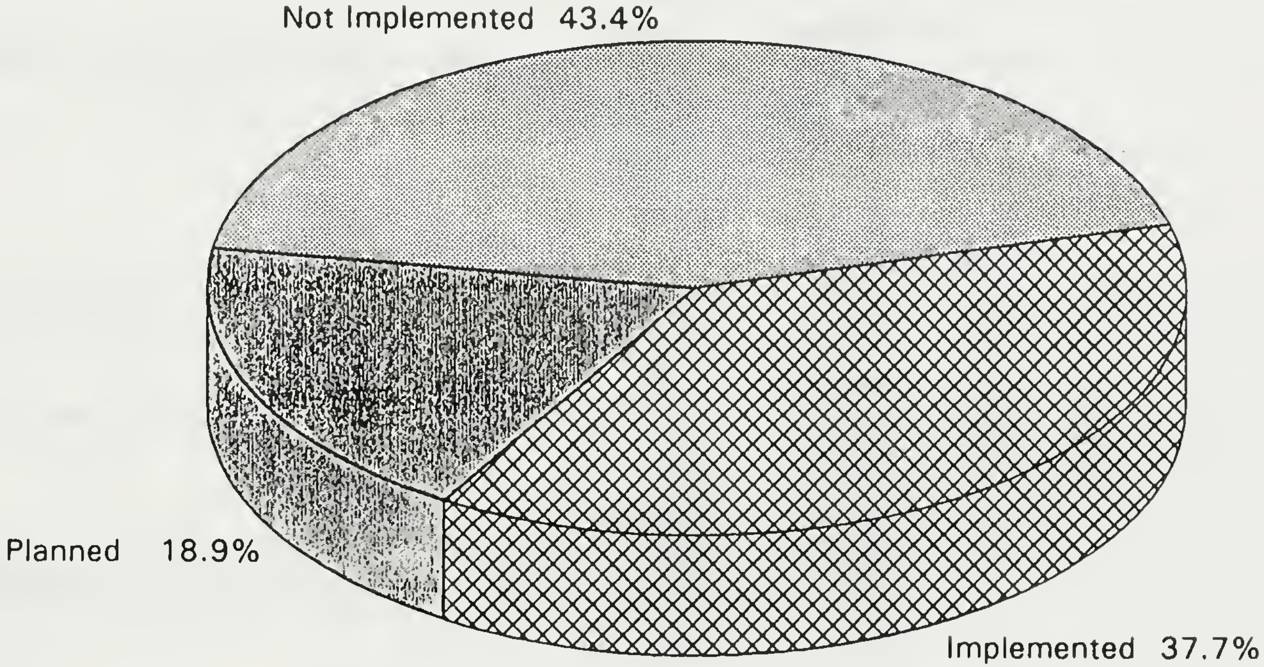


*Figure 1*

ANNUAL SAVINGS RESULTED FROM IMPLEMENTATION OF 53 EEO IN MEAT & POULTRY SECTOR

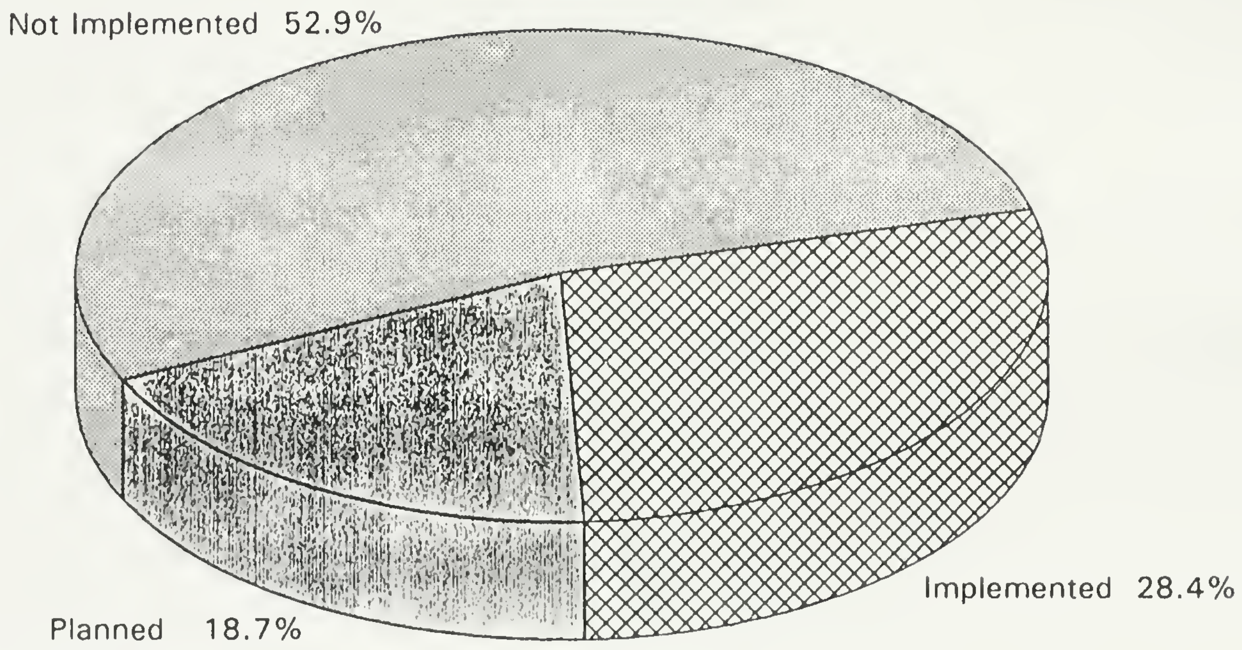


*Figure 2: Total savings = $813,000*

# APPENDIX F

# APPENDIX F

# BACKGROUND ON ENERGY PROCESS INTEGRATION ANALYSIS

Energy Process Integration analysis involves the following sequential steps:

- Formulation of mass and heat balances to describe processes.

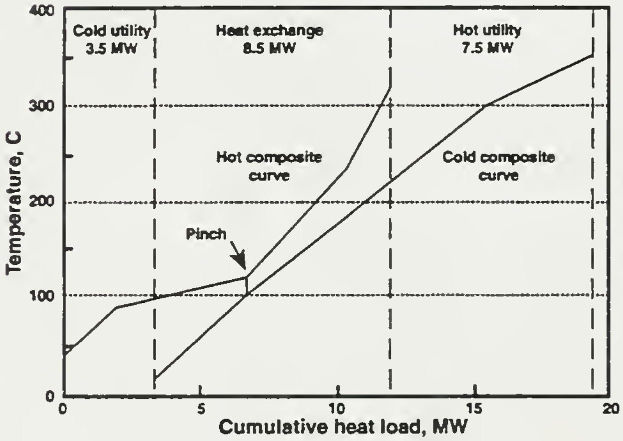
- Logical organization of the energy flows in these processes to identify all cold streams that require heating, and all hot streams that require cooling.

- Graphical construction on temperature-enthalpy diagrams of the Composite and Grand Composite Curves, as shown below, to illustrate the summary energy flows for all processes analyzed. Wardrop employs a specialized proprietary software package for this task.

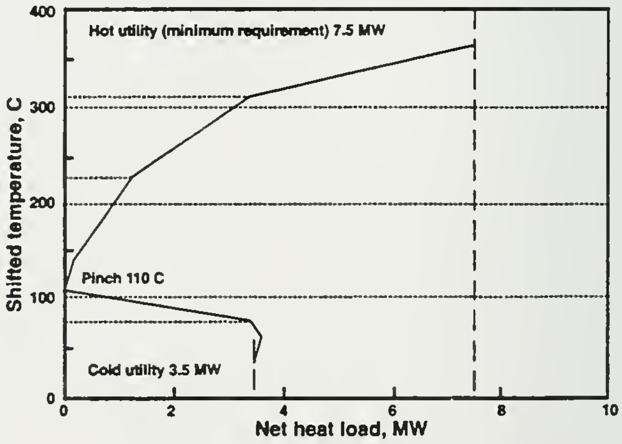
- Identification from the curves of the minimum energy use targets for the hot utilities (e.g., steam) and cold utilities (e.g., cooling water and refrigeration). These targets, which are thermodynamically feasible minimums, allow plant management to assess present energy efficiency, and to establish, with confidence, specific goals to reduce energy costs. The curves also define the PINCH, or the closest overall temperature approach, which has special significance in determining appropriate heat exchange.

- Reorganization of a heat recovery network, based on a simple set of systematic rules, to improve efficiency and to avoid costly inappropriate heat exchanges that may exist. The PINCH approach also prioritizes the heat recovery opportunities for future planning. Identified efficiency improvements can be undertaken with the confidence that they are globally beneficial, without hidden energy costs elsewhere in the plant.

- Modification, as necessary, of utilities to better suit the requirement of the processes. Inappropriate or unnecessary utilities can be restructured or eliminated to reduce costs. Appropriate opportunities for cogeneration can also be identified.



COMPOSITE CURVES



GRAND COMPOSITE CURVE

Energy Process Integration is flexible, and can be applied effectively to an entire complex, to selected areas, or even to individual processes. The procedure allows for evaluation of new process designs, auditing of the energy efficiency of existing operations, and decision support in review of process modifications.

I